THE ENGINEER.

The Shipping, Engineering and Machinery Exhibition at Olympia.

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In a time of deep industrial depression, such as that which has now overtaken not only this country, but also the world at large, it is gratifying indeed to find that manufacturers are still able to give their whole-hearted support to the Shipping, Engineering and Machinery Exhibition at Olympia, and that the present Exhibition, which opened on the 10th of this month and will remain open until September 26th, fails in no way behind its predecessors in either the quality, quantity or interest of the various machines and devices shown. As was the case in many of the previous Exhibitions, and for reasons that are well understood, the Machine Tool Trades Association has again withheld its support. In consequence the machine tool makers of this country are hardly represented, and exhibits of this kind are almost confined to those of foreign manufacture. In this connection it is interesting to note that at the Machine Tools Exhibition to be held next year the decision has been made that foreign manufacturers, including German, will be allowed to exhibit. But even allowing for the omission of this important branch of engineering, there is so much of interest there and so wide a field is covered by the other branches of engineering that the attention of our profession is certain to be focussed upon the Exhibition for the full period of its existence.

In this Supplement we have endeavoured to give some idea of the variety of the exhibits to be seen and to describe them fully, not only for the benefit of those who will have an opportunity of seeing the stands for themselves, but also for those whose business engagements or whose domicile abroad makes it impossible for them to attend the Exhibition. Within the limits of this Supplement, of course, it is impossible to notice all the principal exhibits at the show, but descriptions of other important exhibits will be found in our ordinary columns, both in this week's issue and those to follow.

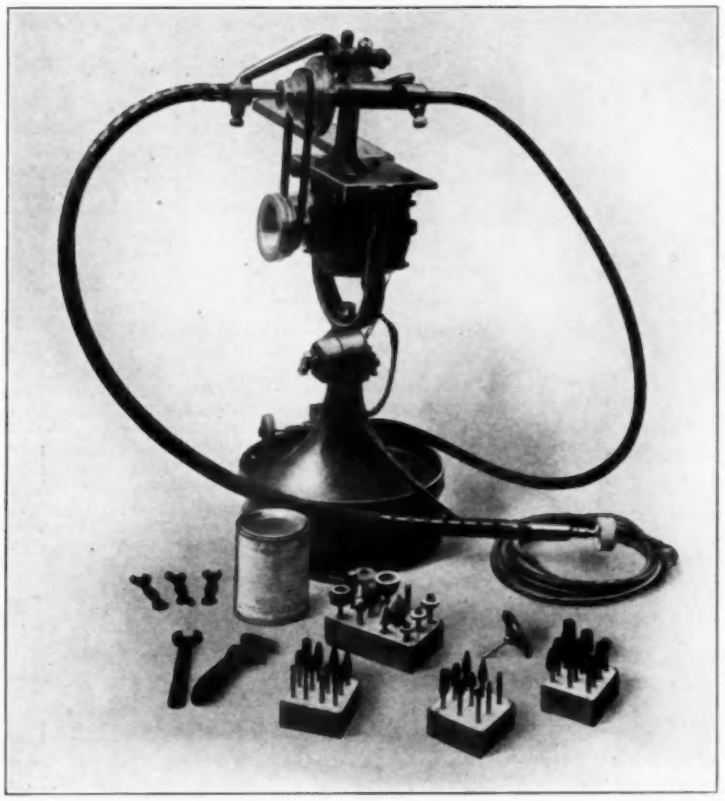


Fig. 1—½ H.P. Flexible Drive Bench Machine—Gilman

F. Gilman (B.S.T.), Ltd.

It may be that, with the more extensive use of water-softening plant, either of the chemical or evaporative type, the necessity for scaling boiler heating surfaces is becoming less acute than it was, say, a decade ago, but still there are steam raising plants which have to work with crude water, and consequently are subject to the deposition of scale, and every engineer appreciates the danger and loss consequent on the deposit of calcareous scale on heating surfaces. There are also other places in which deposits on metallic surfaces may be very harmful, such as the bottoms of ships, and any means whereby they may be readily removed are welcome.

The little plant which we illustrate in Fig. 1, which is made by F. Gilman (B.S.T.), Ltd., of 221, High-street, Smethwick, is intended for neither of these individual jobs, but it is indicative of the class of machinery made by this firm for scaling work of a general character, and has the merit that it is a new model designed for bench work in the shop. That is to say, it is intended to provide a means for driving a mobile rotary tool, which can be used for almost any conceivable machining purpose.

It is really a very simple affair, comprising a ½ H.P. motor mounted in gimbals on a base, which may be bolted down or not as desired. Above the motor there is a countershaft, which is driven by a vee belt to give four speeds. In connection with this countershaft there is an overhanging arm to carry a bearing that leads the end of a length of flexible shafting fair, and in line, to the end of the countershaft, regardless of its flexure beyond this bearing. This flexible shaft provides the main drive of the machine, which may be used for a great variety of purposes; but there is also a secondary drive to give a much higher speed, the flexible shaft from which can be seen on the right of our illustration. This drive is effected through a friction wheel on a swinging bracket being brought to bear on the periphery of the countershaft speed cone. It is only necessary to withdraw a plunger to put either one or the other of the drives out of action.

The range of speeds which may be obtained with this machine from the direct drive is 850, 1750, 2375, 3000 r.p.m., and on the high-speed drive four further speeds are available, 3400, 7000, 9500, 12,000 r.p.m. The direct drive shaft in the four lower speeds is mainly used for the larger working heads, such as wire brushes, fibre brushes, polishing mops, grinding wheels, drilling heads, cellulose polishing heads, sanding heads, rotary files, and rotary millers, whilst the high-speed drives are employed for use with small rotary grinding wheels of various shapes, rotary felt polishers of various shapes, small wire brushes for burnishing, small polishing mops, and small high-speed drills. The majority of the attachments are held in a small collet chuck. The machines are provided for any voltage, A.C. or D.C., and are usually supplied to operate off lighting circuits or single-phase supply; 11 mm. core flexible shafting is used for the heavy drive and 6 mm. or 8 mm. core flexible shafting for the high-speed drive.

The rubber coverings for the flexible driving shafts, which are made by Messrs. Gilman, are strengthened by strip spring strengtheners, and are lined internally with spiral steel strip liners, which give the shaft a long life.

British Insulated Cables, Ltd.

A selection of the latest types of electric welding machines for butt and spot welding is to be seen on the stand of British Insulated Cables, Ltd., of Prescot, Lancs. The company's No. 92 automatic butt welder for welding sections in sizes up to 3 square inches, and an automatic spot welder are shown in operation. A three-head 30-kW rivet heater of the latest pattern and designed to heat rivets up to 1in. in diameter is also demonstrated. Examples of electric wiring in a ship's cabin and alleys carried out with the company's specially designed cables for ships; examples of electric cables and wires and paper pinions constitute other exhibits. The butt welder shown in Fig. VI. in the second Supplement may be fitted with a power drive and automatic gear for making the machine fully automatic. The parts to be welded are fixed in clamps in the usual manner, and by closing a switch the slide is set in motion by means of the small motor shown, or in certain cases the power may be taken from an existing line shaft. The slide is drawn back a small distance, and the current is switched on, and the slide then moves forward. When the parts to be welded make contact the flashing takes place in the usual manner, and after a predetermined time the full upsetting pressure is exerted, which consolidates the metal at the weld, and the current may be switched off and the clutch disconnected. The article is then released from the clamps, and by reversing the small control switch the slide is opened ready for the next weld. When once the correct settings have been made and as long as the conditions remain constant, any number of identical welds can be made.

The machine is suitable for the slow welding of mild steel sections having cross-sectional areas up to 3 square inches, the capacity of the single-phase transformer being 50 kW for slow welding and 80 kW for flash welding. The ends of the transformer secondary are connected to two slotted platens on which various types of clamps may be mounted, one of these platens being fixed to the cover casting, while the other is fitted to a cast iron saddle which moves on machined surfaces on the cover, as shown. By this arrangement it is possible to avoid passing the current through moving contact faces, and to provide a slide which may be oiled. The type of clamps fitted depends upon the class of work the machine is required to weld. Cooling water nipples are fitted where necessary for connection to rubber hose. A stop is provided on the main spindle of the upsetting gear to enable the lever to be raised to the same position after each weld. A plug box situated at the left-hand side of the machine provides for eight heating speeds, and an A.C. contactor connected to the main source of supply and arranged for wall mounting is fitted for making and breaking the supply to the machine. This contactor is operated by a two-way "open" and "close" push-button, fitted to the welder.

As regards the electric rivet heater, the machine shown is one of a range of these machines made in capacities up to 50 kW, with one, two, and three heads to meet different requirements. The machine exhibited consists of a steel frame structure, substantially built to carry a single-phase static transformer. The primary windings consist of solid drawn, high conductivity copper strip, insulated and impregnated and stoved after winding. Tappings are taken from the primary and connected to a plug box to give eight different heating speeds.

The secondary circuit is of cast copper, designed to give a large cooling surface. The contact blocks are of solid drawn, high conductivity copper, and the top electrode is provided with a vertical adjustment to suit varying lengths of rivets.

The spot welder shown in Fig. VII. is a heavy machine suitable for making welds up to ½in. in diameter in an added thickness of mild steel of ⅛in. to ¾in., at a speed of up to 600 welds per hour, and, as shown in the illustration, is arranged for a power drive. The machine consists of a 60-kW single-phase, air-cooled, static transformer enclosed in a substantial cast iron body. The stakes or arms may be either 24in. or 36in. long, the top arm being of cast iron with a slide block fitted at the end. To the underside of the cast iron slide block a cast copper electrode carrier is fitted, and flexible connections are run to one side of the transformer secondary. The bottom stake is composed of cast copper, and is fitted directly to the other end of the transformer secondary. Each stake carries a water-cooled electrode arranged to take renewable hard-drawn copper tips. The top electrode is adjustable in height to accommodate various thicknesses of material, and the thrust is taken by an adjustable abutting screw attached to the slide block. The water-cooling nipples on the electrodes are arranged to fit inside a ¼in. bore rubber hose. The mechanical pressure for the weld is varied by springs fitted to the head of the machine.

Driving power is applied through an electro-magnetic clutch arranged with push-button control. The main switch consists of a separate contactor arranged for wall or panel mounting, and is auto-

FIG. 2—MERCURY-IN-STEEL THERMOMETER—NEGRETTI

matically operated by the driving motion. Eight heating speeds are provided by a double plug box.

The main feature of the company's cable for wiring ships is the replacement of the lead sheathing by a sheathing composed of special flexible waterproof material which is highly resistant to vibration, abrasion and mechanical damage. This material is also said to be practically inert to the action of hot engine oil and sea water, and has proved to be suitable for ambient temperatures up to 150 deg. Fah. Over this sheathing a tape, braid and a special paint are applied in order to protect the sheathing from mechanical damage. The dielectric of the cable is homogeneous and consists of a high grade vulcanising rubber specially designed for high ambient temperatures. The layer of pure rubber usually applied next to the conductors is omitted, as it is unsuitable for high temperatures. In the case of single cables, the conductors are insulated with the special type of vulcanising rubber. A sheathing of special flexible waterproof material is then applied and is followed by a tape, braid and paint. For multicore cables it is considered necessary to eliminate the jute wormings between the cores. The cores, insulated with the special vulcanising rubber and taped distinctively, are laid up with a soft rubber centre, then wormed and sheathed with the special waterproof material as applied to the single cables, and protected with tape, braid and paint.

We are told that the cable has successfully withstood severe tests over a considerable period at the National Physical Laboratory, and the results of these tests are embodied in an N.P.L. report dated December 12th, 1927.

NEGRETTI AND ZAMBRA.

New and interesting instruments for marine use are being shown by Negretti and Zambra, of 38, Holborn-viaduct, E.C. 1. Specimens of high-range mercury-in-steel thermometers—see Fig. 2—for Diesel exhaust temperatures up to 1200 deg. Fah., constructed on the well-known principle employed in all the firm's distance thermometers are on view. The direct-action movement dispenses with gears and levers and eliminates backlash, whilst the compensated capillary tubing prevents the reading of the instrument being affected by change of temperature of the surrounding air. When it is considered that the selection of a suitable material for the bulbs of these instruments is not only a question of tensile strength at a dull red heat, but also of the creep stresses and permanency of structure at that temperature, it is evident that the production of these thermometers has involved much thought and experimental work. Owing to the internal pressure of the mercury, the bulb is required to stand a very considerable stress at the high temperature, and it is of the greatest importance that there shall be no change in its structure even if it be subjected to a dull red heat for some considerable time. The volume of mercury expelled from the bulb when it is heated represents

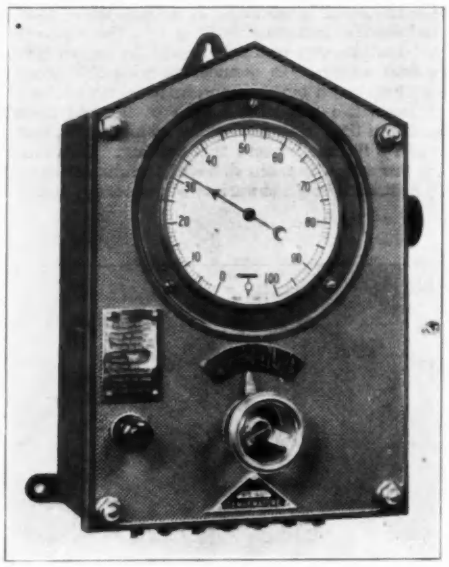


FIG. 3—ELECTRICAL DISTANCE THERMOMETER—NEGRETTI

only a small head of the mercury, and consequently any permanent change in the volume of the bulb would affect the reading. At the present time there are many heat-resisting steels, such as nickel-chromium alloys, giving a creep stress of 9 tons per square inch at 600 deg. Cent. and 6 tons at 700 deg. Cent. which have physical properties approaching those required for the bulbs of these thermometers, and a large number of experiments have been carried out on these materials. The firm's new boost gauge, which shows the absolute pressure in the Diesel engine supercharged air inlet pipe, irrespective of barometric variation, consists of a sensitive diaphragm movement mounted in an air-tight case with one connection leading to the inlet pipe. For measuring refrigerated chamber temperatures several kinds of thermometers are shown, including the mercury-in-steel type with bold figures on the dial or with an open reading circular chart which may revolve once in one, seven, fourteen, twenty-eight, or fifty-six days. There is also a photographic temperature recording apparatus which by photographing the readings of a standard mercury thermometer every six hours during a long voyage gives a record that cannot be questioned. Another exhibit is a standard bimetallic recording thermometer, which can also be supplied with a specially large drum taking a chart 26½in. long by 4¼in. wide and revolving once in fifty-six days. The "all-mains" "Wheatstone bridge" electrical distance thermometer shown in Fig. 3 is

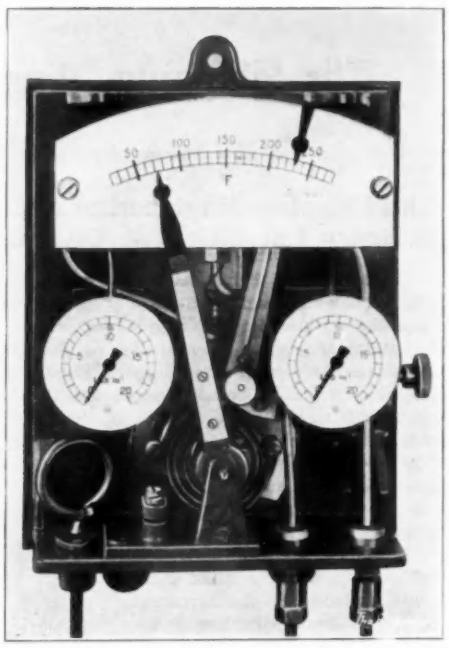


FIG. 5—AUTOMATIC CONTROL APPARATUS—NEGRETTI

another exhibit. The instrument requires no batteries, as it derives its current from the electric supply circuit and is connected to the bulbs, which may be any distance away. Other exhibits consist of indicating and recording pressure gauges of improved design, dial depth gauges, thermo-electric pyrometers for high temperatures, and a new automatic control apparatus—see Figs. 4 and 5—designed to maintain any given condition, such as temperature, within close limits. In the case of the arrangement shown in Fig. 4 compressed air at a pressure of 15 lb. per square inch enters the controller through the pipe A, and then passes through a restriction C to the diaphragm of the steam valve F and also to the leak valve E. When the temperature of the bulb G—placed in the medium to be controlled—rises it causes the Bourdon tube H to uncoil, thereby opening the small leak valve E and causing the air pressure in the pipe

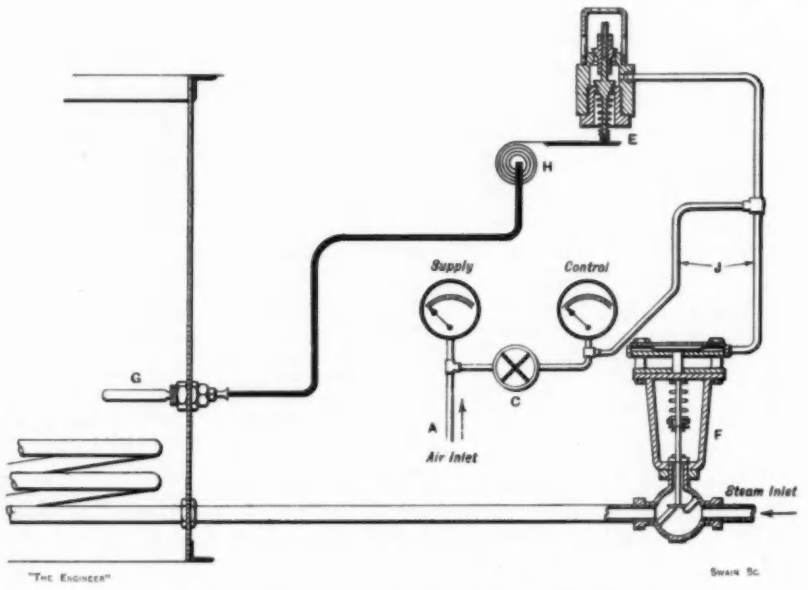


FIG. 4—DIAGRAM OF AUTOMATIC CONTROL APPARATUS—NEGRETTI

line J to decrease, thus causing the valve F to close or partially close, with the result that the supply of heating steam is regulated.

AUTO-KLEAN STRAINERS, LTD.

Since the 1927 Exhibition there has been a well-marked advance in the degree of fineness necessary for the straining of fuel and lubricating oils, which has in the main been brought about by developments in high-speed airless-injection oil engine practice. The advance referred to is well illustrated in the

exhibits on the stand of Auto-Klean Strainers, Ltd., of 40, Trinity-square, London, E.C. 3. The company is showing a wide variety of designs of its patented self-cleaning non-collapsible gauzeless strainers for fuel and lubricating oils, also for chemical and industrial liquids. It may be recalled that the "Auto-

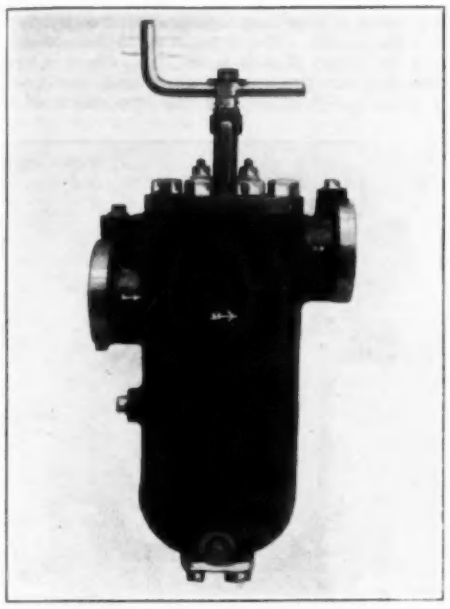


FIG. 6 COMPLETE ASSEMBLY OF AUTO-KLEAN OIL STRAINER

Klean" strainer consists of a series of thin plates pierced in the form of a spoked wheel, which are mounted on a central spindle. Between each plate there is a cleaning blade, which is threaded on a fixed rod, so that when the cartridge formed by the superimposed straining plates is turned by a handle projecting through the cover of the filter—see Figs. 6 and 7—the blades scrape out any deposit which may be present in the finely divided spaces between adjacent straining plates. The arrows shown in Fig. 6 indicate the flow of oil through the strainer, the body of which is furnished with a lower door for cleaning out sediment. For the smaller sizes of strainer a single pack suffices, but in strainers of large output, such as the one we illustrate, the makers have adopted a series of smaller packs which are furnished

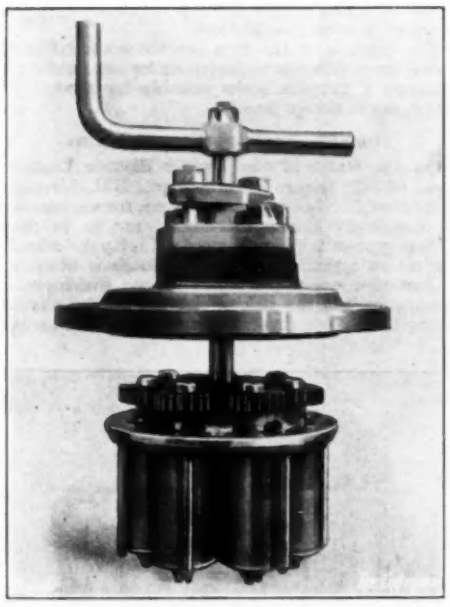


FIG. 7—ARRANGEMENT OF FILTER-PACKS OF AUTO-KLEAN STRAINER

with gear wheels at their upper ends which mesh with the central spindle.

When the "Auto-Klean" strainer was first put on the market, the standard of straining was equivalent to an 80-mesh gauze for lubricating oil and 100-mesh for fuel oil. Current practice, however, demands an equivalent of 150-mesh for large size oil fuel strainers, and in some cases an equivalent degree of fineness for high-speed engine lubricating oil. In this connection it may be remarked that the type of strainer illustrated in Figs. 6 and 7 was employed by Rolls Royce, Ltd., for test bed work on the engines for the new Vickers Supermarine Rolls Royce 8 6 machines. Strainers are now built to retain particles of only 0·0005in. magnitude.

In Figs. 8 and 9 we show a new type of "Auto-Klean" strainer, in which the principle of edge filtration has been retained, but new features have been incorporated under Selley's provisional patent. The pierced discs are built into a number of cartridges, which, as in the design previously described, are geared to a central spindle. The upper part of this spindle carries the rotor of a semi-rotary hand pump for cleaning the strainer. In order that the flow through the strainer shall be maintained during the cleaning operations, it has been found convenient to divide the cleaned oil portion of the strainer into two parts by an isolating web, placed diametrically across the centre chamber. When the pump handle is moved towards the operator, oil is forced back through one-half of the cartridges, while when it is moved in the opposite direction oil is pumped back through the other half of the cartridges. As the pump

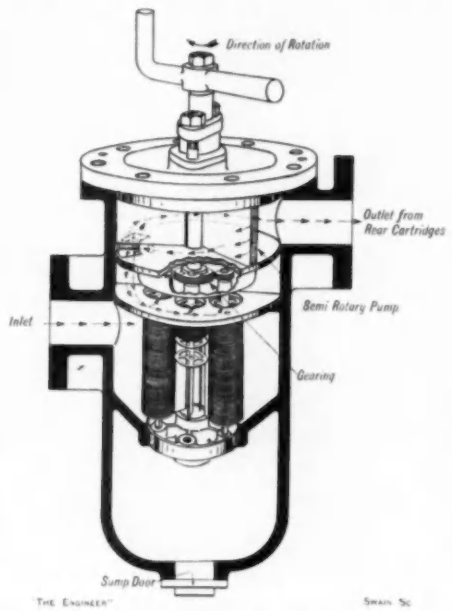


FIG. 8 SECTION THROUGH AUTO-KLEAN STRAINER

handle is moved, the cartridges revolve on their own spindles against a scraper. In this particular design, the scraper blades are stationary, there being one for each cartridge, extending the whole length of the straining area. Each scraper fits against, but is not pressed on to, the cartridge, its action being to collect the sludge loosened by the reverse flow of the liquid and direct it into a central duct and sump for subsequent removal. The makers claim that by this construction there is no liability of grit being forced through the mesh of the strainer—as might occur if cleaning were by scraping only—or for the sludge to be flushed off and then redeposited, as might conceivably occur when only a reverse flow is used. While retaining the principles of edge filtration, cleaning by reverse flow and scraping the surface of the cartridge, the construction of the Seeley strainer combines all these methods in such a way, it is claimed, that a sharp double stroke of the pump handle cleans the strainer without disturbing the flow of liquid. Moreover, the whole apparatus is strongly built, the cartridges which form the straining medium being solid and rigid.

Fig. 8 illustrates the action of the pump when cleaning the front cartridges, as the handle is moved sharply in the direction of the arrow. During the stroke the oil continues to flow through the other

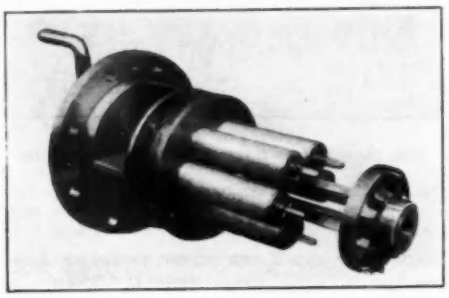


FIG. 9—ASSEMBLY OF FILTER-PACKS AND SCRAPERS—AUTO-KLEAN

cartridges, which are in turn cleaned by the reverse stroke, the flow of oil through the strainer thereby being unbroken.

W. H. DORMAN AND CO., LTD.

A comprehensive arrangement of compression-ignition oil engines, designed to use heavy fuel oils, along with paraffin and petrol motors for both land and marine service, forms the principal feature on the stand of W. H. Dorman and Co., Ltd., of Stafford.

In our issue of June 26th last we described in detail the design and construction of a two-cylinder Dorman compression ignition engine, working on the Acro four-cycle principle, which has a cylinder bore of 110 mm. and a stroke of 1800 mm., the designed output being 12 B.H.P. at 600 r.p.m., and a maximum of 35 B.H.P. at 1800 r.p.m. This engine, along with a four-cylinder unit with the same cylinder sizes, having an output of 43 B.H.P. at 1000 r.p.m., is shown. We give in Fig. X. in the second Supplement three views of the four-cylinder high-speed marine engine of the same type, which has a cylinder bore of

FIG. 10—40° "FLEXSTEL" FLEXIBLE BALL AND SOCKET JOINT—DORMAN

120 mm., with a stroke of 180 mm., an operating speed of 1000 r.p.m., and an output of 50 B.H.P. There are incorporated in the design many of the features which we described in the above-mentioned article.

The firm is also showing on its stand four-cylinder marine type paraffin engines, with outputs of 30 and 16 B.H.P., at 1000 r.p.m. Some of these models are mounted on inclined bases, with the control board attached so that an exact representation of the engine as it would appear in the ship is given.

The application of the Dorman engine is further illustrated by a Gwynne type trailer fire pump, with a designed duty of 100 gallons per minute, and a Holman air compressor set, while the use of the compression-ignition engine for locomotive service is also demonstrated.

Alongside the engines is a display of the firm's patented "Flexstel" flexible ball and socket and rotary joints. Typical examples of a 40 deg. double socket bend and of the use of such flexible joints in a steam main for expansion purposes are shown in the accompanying Figs. 10 and 11. The ball joint is so designed that it will withstand high-pressure water, gas or oil; it will carry high-pressure, saturated and

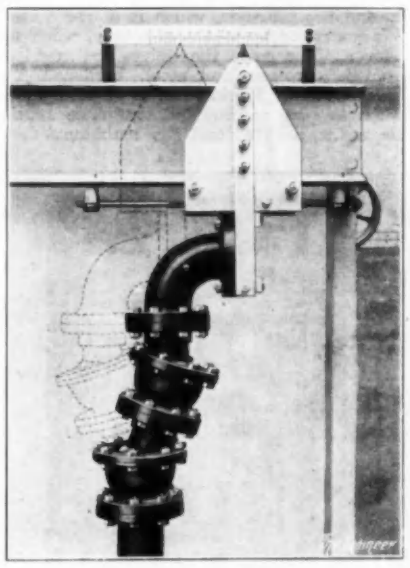


FIG. 11—USE OF FLEXIBLE JOINTS IN A STEAM MAIN—DORMAN

superheated steam, and also light spirits, such as petrol, or acids and other chemical liquids. The fittings are standard productions, embodying British standard pipe threads and flanges, and range from the smallest bores up to bores 10in. in diameter. The makers have devised a flexible connection for unloading oil tankers at the docks, which incorporates these flexible joints, and includes a lifting gear to balance the weight of the pipes and connections. Such installations are guaranteed to work at pressures up to 400 lb. per square inch, and to operate with 40ft. rise and fall of the tide beside the quay, 15ft. fore and aft and about 14ft. broadside movements. Other items shown on the Dorman stand include typical high-pressure die casting machines for the production of die castings in lead, tin, or zinc base alloys. The firm has also specialised for some time past

in the production of grey iron castings, and castings in aluminium and aluminium alloys; various examples of such castings are to be seen on the stand.

THE UNITED MACHINE TOOL COMPANY, LTD.

Among the exhibits of the United Machine Tool Company, Ltd., of Holborn Hall, London, are drilling machines, lathes, and other machine tools. The drill illustrated in Fig. 12 is made by Franz Braun A.G. It will be seen that the driving motor is mounted directly above the spindle, and that the controls are conveniently grouped. An ammeter is also included with the object of indicating to the operator whether he is using the machine to the maximum of its capacity. The base-plate is strongly ribbed and fitted with a trough which drains the coolant back into a tank cast integrally with it. The arm is of oval section and is strengthened internally by zigzag webbing to provide extra resistance against the various strains which it may encounter. The feed is engaged and disengaged by means of a quick-acting clutch, and the gear-box, which is of the motor car type, is controlled by means of a hand wheel and a hand lever. The gears themselves are made of 85 tons tensile chrome-nickel steel, hardened, chamfered and ground. Rapid reversal of the spindle for use when tapping is provided for. The maximum spindle radius is 3ft., and the maximum distance from table to spindle 2ft. 3½in. There is a range of six feeds from ·0047 to 0·0473 inch per revolution, and twenty-four spindle speeds from 80 to 1200 r.p.m. Another machine of a similar type, but larger, is also shown.

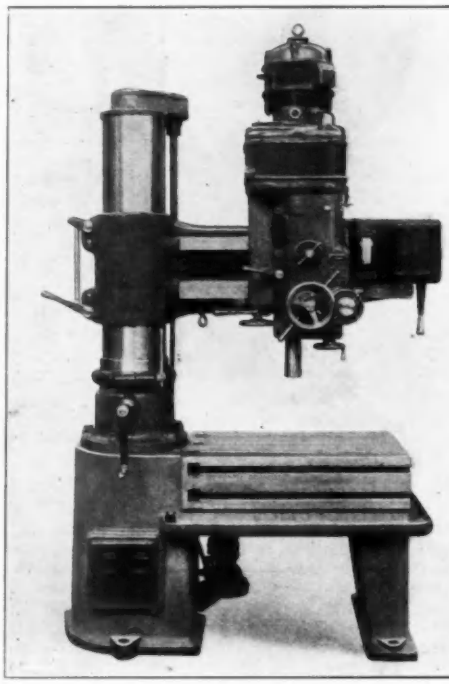


FIG. 12—RADIAL DRILLING MACHINE—UNITED MACHINE TOOL

FIG. 13—COLUMN DRILLING MACHINE WITH HYDRAULIC FEED—UNITED MACHINE TOOL

Another drill made by Hille Werke A.G. is illustrated in Fig. 13. The most interesting feature of the design is the arrangement of the hydraulic feed gear. A stationary pump cylinder is fitted with a piston having a variable stroke, and this gear takes the place of the more usual reducing valve. The volume of oil used, it is claimed, is practically constant for all pressures, and it is therefore possible to adjust the required feed by means of a hand wheel with a graduated scale, regardless of the size of the drill used.

The machine illustrated in Fig. XII. is shown in operation at the Exhibition, producing a complicated steel bolt, 10in. long, from the bar. This turret lathe is made by Pittler Werkzeugmaschinenfabrik A.G., and its particular feature is the arrangement of the vertical turret head. This arrangement, it is claimed, makes the tool set-up very simple, even for the production of form parts, by the use of single point tools. The turret will accommodate up to sixteen tools. No cross slide is provided. The functions of the cross slide are carried out by a rotary movement of the turret, which is fitted with a power feed. It is claimed that the accuracy of the work produced is increased, owing to the fact that both the longitudinal and transverse feeds are carried out by the turret head itself. The machine shown has a capacity for bar work up to $2^{9}/_{32}$in. in diameter, with a maximum turning length of $26\frac{3}{4}$in. When using a chuck the greatest diameter that can be accommodated is $11^{13}/_{16}$in. Eight feeds and sixteen spindle speeds are provided for in the gear-box. The machine illustrated is fitted with a compressed air-operated chuck, the piping and gauge for which can be seen in the engraving.

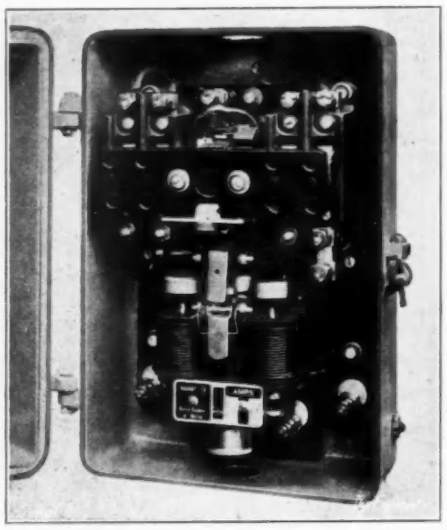


FIG. 14—STARTER WITH PHASE FAILURE PROTECTOR—IGRANIC

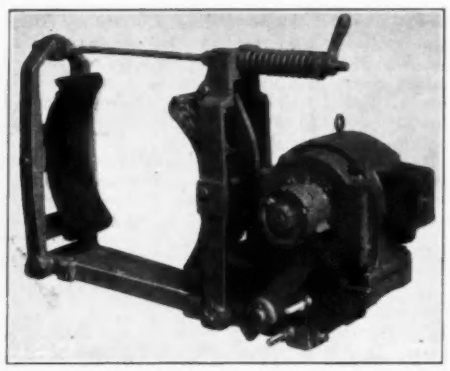


FIG. 15—MOTOR-OPERATED BRAKE—IGRANIC

EQUIPMENT AND ENGINEERING COMPANY, LTD.

The trend of present-day design lies in the direction of reducing the weight of machines and parts of machines by using stronger materials and stressing them more highly. Considerable success has been achieved, but troubles which existed formerly, but were not of such great importance, have followed upon this development in design. Chief among these troubles is the occasional presence of small and frequently invisible cracks in parts subject to fatigue conditions. In highly stressed parts the existence of such a crack, although so minute, may have serious consequences if the job is put into service, while by the action of corrosion or some other means such cracks may develop in service. The serious consequences that may follow upon the failure of important parts have caused careful inspections to be made periodically. But the cracks are frequently so small that detection may be a costly matter.

With the object of ensuring detection the Equipment and Engineering Company, Ltd., of 3, Norfolk-street, W.C. 2, has had upon the market for some time a device known as the electro-magnetic crack detector. Briefly, the process involves magnetising strongly the part to be examined. It is therefore only applicable to iron and steel parts. The part to be examined is placed in such a way that its two ends come into contact with the poles of a large electro-magnet and complete the magnetic circuit. The lines of force run smoothly along its length if it is sound, but where a crack exists they are broken and north and south poles are respectively formed on the two edges of the crack. Such a state of affairs is detected by pouring a special ink over the part. The granules contained in the ink adhere to the edges of the crack and form a line showing up distinctly on the surface of the part. Magnetisers of various types suitable for large and small parts are shown on the stand. Any source of D.C. supply may be used for energising the electro-magnet, but, of course, the energising coil must be suitable for the particular voltage employed. A potentiometer control is used for regulating the magnetising current. This is so arranged that when the test has been concluded the magnetic flux through the part can be reversed to remove any residual magnetism that might have a harmful effect when the part is again put into use.

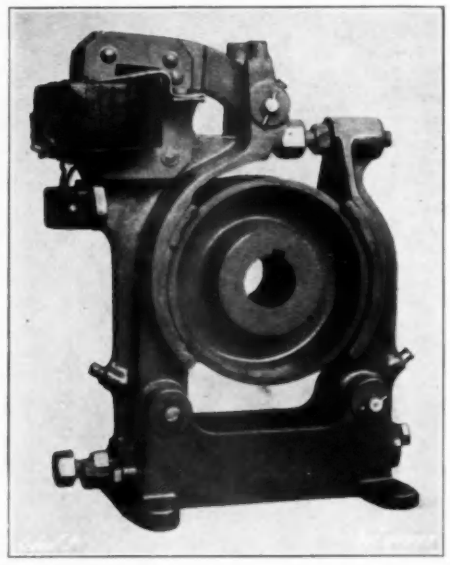


FIG. 16—SOLENOID-OPERATED BRAKE—IGRANIC

The exhibits of the firm are not confined to this useful crack detector; electrodes for arc welding and a range of Simplex jacks suitable for a variety of purposes are also to be seen.

IGRANIC ELECTRIC COMPANY, LTD.

On the stand of the Igranic Electric Company, Ltd., of 147, Queen Victoria-street, E.C., interesting examples of self-acting control gear, for various types of electrically driven machinery, are to be found. A new type of triple-pole overload relay for affording protection against excessive overloads is fitted with an instantaneous phase failure release, which protects motors against the risk of damage to the windings owing to the interruption of one phase of the supply.

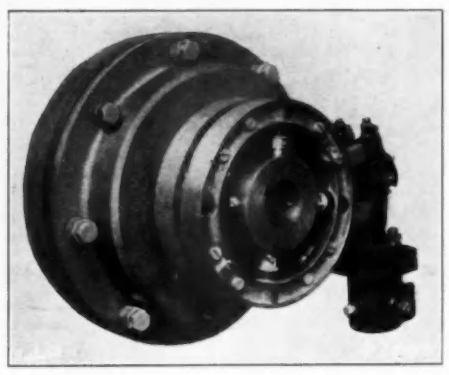


FIG. 17—MAGNETIC CLUTCH—IGRANIC

This device, we are told, is being incorporated in many types of starting and control apparatus, including the firm's small push-button "across the line" contactor starter—Fig. 14—for squirrel-cage motors. The incorporation of this type of overload protection into crane motor protective panels constitutes a recent development, and examples of these panels with this device are displayed. There are also magnetically operated D.C. and A.C. contactors and master and auxiliary control devices. An exhibit worthy of special attention is a new double-pole

pressure-operated switch for the automatic starting and stopping of compressors driven by A.C. motors up to 2 horse-power. Motor and solenoid-operated brakes, as illustrated in Figs. 15 and 16, respectively, are also exhibited. In both cases the brake is applied by powerful springs, and released in the case of the brake shown in Fig. 15, by a squirrel-cage motor and by an electro-magnet in the case of the brake shown in Fig. 16. In the design of these brakes an endeavour has been made to reduce the number of moving parts to a minimum, and to secure the utmost reliability. The firm is also showing three magnetic clutches, which are made in sizes ranging from 7in. to 78in. in diameter, and for various transmission capacities up to 2000 B.H.P. One of these clutches, which is 16in. in diameter and which has a torque rating of 732 lb.-feet, is shown in Fig. 17.

MIRRLEES, BICKERTON AND DAY, LTD., AND THE MIRRLEES WATSON COMPANY, LTD.

The principal exhibit on the stand of Mirrlees, Bickerton and Day, Ltd., of Hazel Grove, near Stockport, is one of the firm's latest productions, the "Mirrlees-Ricardo" high-speed oil engine. This type of engine is manufactured in two different cylinder sizes, namely, 20 B.H.P. per cylinder and 50 B.H.P. per cylinder, giving a wide range of powers. The engine exhibited, illustrated in Fig. 19, is a six-cylinder unit of the smaller cylinder size, which is rated at 120 B.H.P. when running at 1200 r.p.m., and has cylinders with a 5⅝in. bore and a stroke of 6½in. It operates on the four-cycle airless-injection principle, and a single sleeve valve for the control of the inlet and exhaust is employed instead of the usual mushroom type valves. The sleeve valve admits the air through ports in the side of the cylinder, and the shape and position of the ports are carefully designed to produce the maximum turbulence of the air charge. The ordered turbulence thereby created renders it unnecessary to break up the fuel very finely before its admission to the combustion chamber, and enables a fuel valve having a single large orifice to be employed, thereby ensuring freedom from choking. The only moving part in the fuel valve is a single spring-loaded steel ball. One fuel pump per cylinder is provided, and both the suction valve and the spill valve are mechanically operated. The engines are designed with pressure lubrication to all main bearings, gudgeon pins and gear wheels, while efficient strainers and an oil cooler form part of the equipment. As shown in Fig. 19, the engine exhibited is a standard unit arranged for direct coupling to a generator, but engines have also been designed for marine propulsion work. When fitted with a reversing, or a reversing-reducing gear, these engines form a propelling unit claimed to be suitable for small craft. They are built with outputs of 60 B.H.P. to 120 B.H.P. in three to six cylinders, the overall dimensions being small, while the engine weights vary from 40 lb. to 50 lb. per brake horse-power. The larger series of engines, with designed outputs of 150 B.H.P. to 400 B.H.P. in three to eight cylinders, are more particularly suited for generating purposes. For such work the engine speed is usually 900 r.p.m., while the design is generally similar to that of the smaller size of engines we have previously referred to.

The firm is also showing a sectioned model of an engine cylinder which indicates clearly the rotary and reciprocating motion of the sleeve, together with its drive. The same model also shows the link motion for the fuel pump, and that controlling the suction and spill valves. When set in motion, it also illustrates the action of the ball and socket joint at the bottom of the sleeve, showing, at the same time, the path of the sleeve ports over the cylinder ports. The fuel control rod, which is operated by the engine governor, and which rotates the circular wedges acting on the fuel pump spill valves, can also be seen. Various parts of "Mirrlees-Ricardo" oil engines

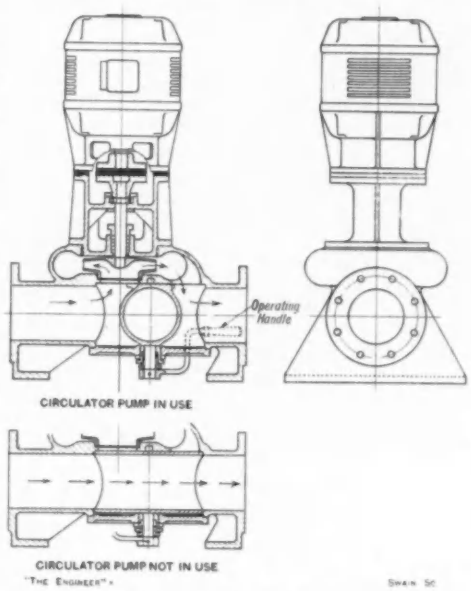


FIG. 18—"CLEARWAY" CENTRIFUGAL PUMP—MIRRLEES

are displayed on the stand, thereby enabling a close inspection of the design and manufacture of the different component parts to be made.

A special feature of "Mirrlees" engines is the extensive use of the Nitralloy process for many of the principal case-hardened parts, and on the stand a group of parts hardened by this process is to be seen. A special alloy steel is used having the mechanical properties of a good nickel-chrome steel with a tensile strength of from 40 to 80 tons per square inch, depending on the grade of steel used. The high core strength of this steel, combined with a case-hardness of over 1000 Brinell, makes the process most suitable for parts subjected to much wear and stress. Owing to the fact that in the Nitralloy process no quenching is required, distortion of the parts and the possibility of quenching cracks are eliminated. The company has had nitriding equipment installed in its Hazel Grove works for over two years, and has had, therefore, extensive experience with this new development. The firm is prepared, we understand, to undertake such work for other firms, and to nitride finished parts or, if more convenient and economical, to manufacture such complete hardened parts as may be required.

On the same stand The Mirrlees Watson Company, Ltd., of Scotland-street, Glasgow, is showing a 4in. multi-stage turbine pump for boiler feed. The type of pump actually on exhibition differs slightly from that shown in Fig. XXII. in that it has six stages and not seven, and its bearings are water-jacketed. It has a designed duty of 200 to 250 gallons per hour against 1200ft. head. For exceptional heads requiring more than eight stages, two pumps operated in series can be supplied. Correct alignment of the stages is obtained by registering them together by means of accurately machined spigots and sockets. The joints of the intermediate pieces are metal to metal, and heavy external bolts make any leakage practically impossible. The rotating parts are balanced carefully before erection. Another exhibit is the 8in. single-stage split-casing centrifugal pump illustrated in Fig. XXI. in the second Supplement. It has a designed duty of 1000 to 2000 gallons per hour for heads between 20ft. and 60ft. This type of pump is specially designed to work against low and medium heads and to deliver any quantity within the range of ordinary industrial and water supply requirements, and may be supplied with either a horizontal or a vertical spindle. The top half of the casing of the horizontal pump—or, in the case of vertical pumps, the front half—may be lifted away to examine or remove the rotor without breaking any pipe joints. The rotating parts are specially balanced in a dynamic balancing machine. For dealing with corrosive liquids parts made of special alloys are supplied. The pumps may be arranged for direct drive by an electric motor or an oil engine or through belting.

Another interesting exhibit is the 4in. Mirrlees patented chokeless centrifugal pump, which is specially designed to deal with unscreened sewage and with other liquids containing solid matter. The particular pump exhibited has a designed duty of 70 to 450 gallons per minute at heads from 20ft. to 90ft. These pumps are supplied in either the horizontal or vertical pattern, with branches from 2in. to 10in. in diameter. An extremely simple form of impeller has been adopted with no vanes or tapering side shrouds of the usual type, but with two or three substantial blades projecting from a back check plate. In the smaller pumps these blades simply form a sinuous port of practically constant section leading from the central suction opening to the outer discharge ring in the casing. The design is one, it is claimed, which has the advantage of giving both mechanical and hydraulic balance.

There is also exhibited a Mirrlees "Clearway" centrifugal pump for hot water heating systems, which is illustrated by Fig. 18. The design is applicable particularly to those systems in which the normal flow is thermo-syphonic, and pumping is required only for quick heating of the building or under very cold weather conditions. Under thermo-syphonic operation the water passes through the "Clearway" valve, which provides the main feature of the apparatus, as it forms simply a continuation of the main pipe line and entirely eliminates resistance to the water flow. At the same time it isolates the pump, no other valves being required. Valve chatter, such as may occur with the ordinary flap valve, is not possible. The motor is mounted directly

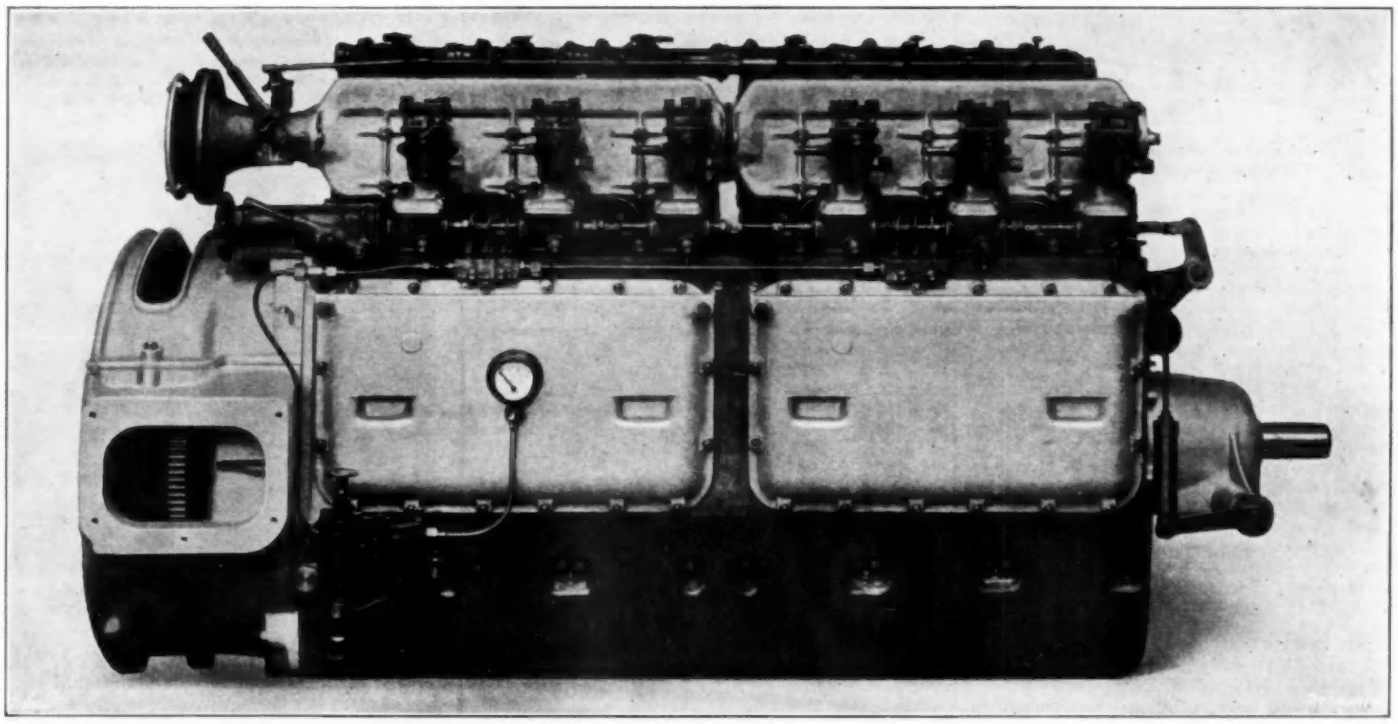


FIG. 19—120 B.H.P. MIRRLEES-RICARDO HIGH SPEED OIL ENGINE

on the pump, and heat transmission to it is prevented by an insulating disc. The complete unit is simply inserted and thus becomes an integral part of the pipe line.

L. STERNE AND CO., LTD.

The exhibits of L. Sterne and Co., Ltd., of the Crown Ironworks, Glasgow, include several examples of the firm's refrigerating plants for marine and land service. One of the principal machines is a vertical enclosed type three-cylinder single-acting CO_2 compressor coupled direct to an electric motor and mounted on a combined bed-plate. This machine has been specially designed for cooling provision chambers on board a passenger liner or for small cargo spaces aboard ship. The cylinders are machined from steel forgings and are fitted with cast iron liners, the piston-rod glands being furnished with metallic packings, which prevent the CO_2 gas from escaping into the crank case. All the working parts are supplied with forced lubrication from an oil pump which is driven by a wrist pin on the end of the crank shaft. Similar machines in one to four-cylinder sizes are built for different duties, and where conditions of working indicate the desirability of such practice, ports can be provided in the cylinder liners for working on the multiple-effect compression system.

In Fig. XXIV. we illustrate another exhibit, which consists of a steam-driven CO_2 compressor. It embodies the main features of the design already referred to and the compressor cylinder and the steam cylinder along with its valve gear are all mounted on a common cast iron crank case, making a very compact arrangement. The box below the crank case serves to house the CO_2 condenser coils, which are made from seamless copper tubing wound in continuous lengths.

Another interesting machine is the two-cylinder ammonia compressor with a direct-coupled motor and a sub-base condenser of the firm's special shell and tube type illustrated in Fig. 20. A feature of the compressor

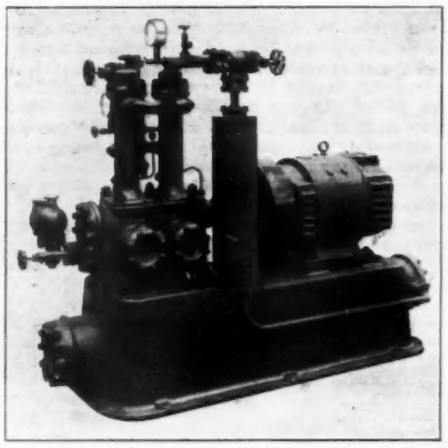


FIG. 20—MOTOR-DRIVEN TWO-CYLINDER AMMONIA COMPRESSOR—STERNE

design is the oil-sealed rotary crank shaft gland, which is necessary in this design, as the crank case is subjected to the suction pressure of the ammonia gas. A 5 or 6 horse-power motor is generally employed with a working speed of 600 r.p.m. This type of machine is supplied for both marine and land use. Further exhibits include a fully automatic ammonia refrigerating plant arranged for electric driving with the motor and the various controls mounted on one bed-plate.

With the object of illustrating the firm's special type shell and tube brine cooler a sectional model has been prepared. It consists of a steel cylindrical shell with tube plates welded at each end of it. The cooling surface is furnished by a number of small diameter tubes which are expanded into the tube plates. The brine or other liquid is pumped backwards and forwards through the tubes and the ammonia is evaporated in the surrounding space, cast iron heads being fitted at each end to distribute the brine in a suitable number of passes. The actual model shown on the stand is about 2ft. long with part of the shell cut away to indicate the arrangement of the tubes and the method of construction. In actual service coolers from 9ft. up to 16ft. in length are manufactured on this principle.

THE MARTINDALE ELECTRIC COMPANY, LTD.

From the point of view of those who are responsible for the operation and maintenance of electrical machinery, the exhibits of the Martindale Electric Company, Ltd., of The Hyde, Hendon, N.W. 9, are of considerable interest. Among these exhibits are small and powerful electric blowers—see Fig. 21—for removing dust from electrical machines. The velocity of the air delivered by these blowers is 312ft. per second, the pressure 30in. W.G., and the discharge over 60 cubic feet of free air per minute. The universal A.C. or D.C. motors are wound for 32, 110, 220 or 250 volts. The weight of the complete machine is 10 lb. Another blower of the same type discharges over 50 cubic feet of air per minute at a pressure of 21in. and weighs 7 lb. The motors used for operating these blowers are wound for the same pressures as those fitted to the more powerful type of blower and are rated at $\frac{1}{3}$ H.P., the capacity of the motor in the other case being $\frac{2}{5}$ H.P.

The firm's "commstones"—see Fig. 22—for grinding commutators may be used on either flush mica or undercut commutators, and are claimed

FIG. 21 ELECTRIC BLOWER IN USE MARTINDALE

readily to remove ridges, flats, high bars, and high mica. They will grind the surface under full speed operating conditions when the bars are held in their true operating position, and every bar is said to be perfectly rounded. They will remove less copper than the most careful workman would remove with a turning tool, and as they are good insulators they may be used whilst generators or motors are working at

FIG. 22—COMMUTATOR STONE—MARTINDALE

their full voltage and under full load. Only two grades of stones—designated C and F—are necessary for grinding commutators and slip rings. The grade C stone is a cutting stone for removing flat spots, ridges or high bars, whilst the grade F stone is for finishing after the commutator has been ground with the other stone. From 75 to 95 per cent. of the cost of turning a commutator is claimed to be saved by

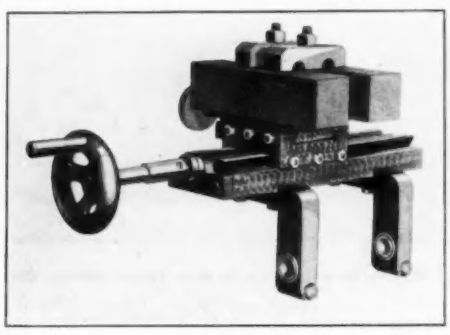


FIG. 23—COMMUTATOR GRINDING TOOL—MARTINDALE

the use of these "commstones." The grade F stone may be used alone for grinding down high mica, for cleaning commutators and for removing small spots.

While the practice of grinding commutators instead of turning them increases every year, the firm has found that there is still a demand for a good commutator turning tool, and to meet this demand it has produced a tool that can be used for grinding or turning. A turning tool block can be slipped on to the tool in place of the stone clamps shown in Fig. 23, and the tool can be used to remove the ridge at the inner edge of the commutator next to the risers. When using the turning tool the commutator must, of course, be revolved slowly, and in the case of large machines the work may often be done without using an auxiliary motor by starting the machine and allowing it to "coast," and by starting to turn when the speed has dropped to a safe value. By repeating the operation three or four times the necessary amount of metal forming the ridge may be removed. The machine may then be brought up to its normal working speed and the work finished with grinding stones. The stud supports and the adjustable wedge blocks are reversible and the top carriage may be run off the bed-plate and turned round, thus making the grinder readily adaptable to nearly all machines.

As regards the advantages of grinding, the makers of these tools point out that if there is any play or

FIG. 24 MICA UNDERCUTTER IN USE MARTINDALE

spring in the mounting of a turning tool it has a tendency to gouge the edges of the bars. A commutator is generally turned at a much lower speed than its normal operating speed, and if any of the bars are loose the tool will push them in, but when the machine is put into service the centrifugal force will raise the loose bars and result in high bars, which will cause jumping and breakage of the brushes and destructive sparking. When the practice of undercutting commutators was first adopted it was found that a turning tool usually left fins or burrs of copper along the edge of each slot, which made it necessary to go over each slot with a scraper in order to remove these fins. If the commutator was re-slotted these fins could usually be removed by the slotting tool, but they sometimes caused inaccurate slotting, slowed up the work and dulled the slotting saws so rapidly that the time and

FIG. 25—COMMUTATOR GRINDING TOOL IN USE—MARTINDALE

cost of undercutting were greatly increased. But a properly designed commutator stone will cut the edges of every bar clean, will leave every bar perfectly rounded, and the grinding is done under full-speed operating conditions. The illustration Fig. 25 shows a grinding tool in use on a 1500-kW rotary converter.

The firm's "Imperial" undercutter—Fig. 24—will cut either a "V"-shaped or "U"-shaped slot. It is simple to adjust, cuts very rapidly and is claimed to work without vibration. There is a micrometer screw to adjust the "V"-shaped slot guide, a roller guide to ride in an adjacent slot to guide the cutter, and a "V"-shaped milling cutter which cuts a "V" slot; but slotting saws for "U"-shaped slots may be used if preferred. There is also a depth gauge to regulate the depth of the slot, and a micrometer screw to adjust the gauge. Power is supplied to the tool through a flexible shaft coupled to a $\frac{1}{4}$ H.P. motor running at

a speed of 1780 r.p.m., but the shaft can be provided with a ball-bearing swivel connection for attaching to any motor with a ½in. shaft. The tool is self-cleaning and is claimed to avoid danger of short circuits between bars, and it automatically prevents undercutting the mica deeper than is desired. It also obviates the necessity of going over the commutator a second time in order to clean out the slots and remove the thin strips of mica left by square-toothed saws. The firm's shop type undercutter, which is supplied with or without an armature stand, is shown in Fig. 26. As the centres of the armature stand are 17in. above the base, the maximum size of armature that can be

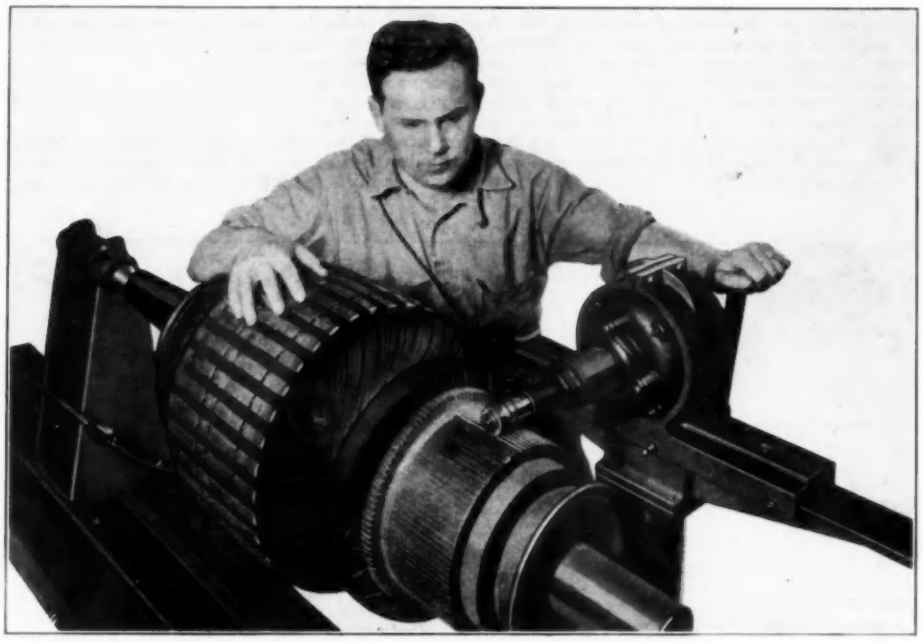


FIG. 26—SHOP-TYPE UNDERCUTTER—MARTINDALE

swung on the stand is one having a diameter of 34in. Without a column extension the machine will undercut commutators of any diameter up to 10in., with a 6in. extension up to 22in., and with a 10in. column extension any diameter from 8in. to 30in. These extensions are inserted between the base of the undercutter motor and the column.

THE PULSOMETER ENGINEERING COMPANY.

The Pulsometer Engineering Company, of London and Reading, is showing a wide range of pumps, refrigeration plants, heating installations, &c. Chief interest at this stand will centre upon the new marine pump designed for general and bilge duties. It is equipped with a rotary exhauster of a novel and ingenious type, so fitted to the machine that if it is

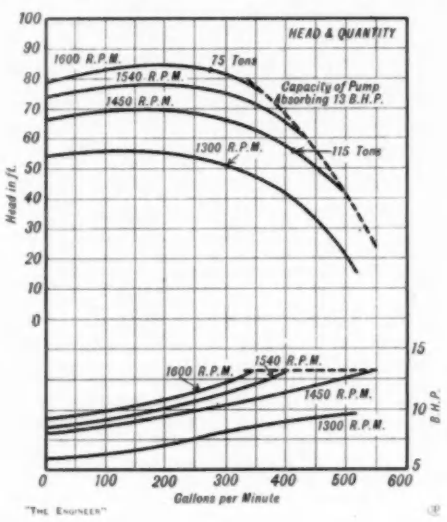


FIG. 27—CHARACTERISTIC CURVES OF 5" MARINE PUMP—PULSOMETER

not required the clutch driving it can be withdrawn. The pump is shown in action.

The nominal capacity of this 5in. marine pump, which is illustrated in Fig. XVIII., is 100 tons of water per hour, and its actual capabilities are shown in the characteristic curves reproduced in Fig. 27. It will deliver 75 tons per hour against a total head of 82ft., or 115 tons per hour against a total head of 55ft., when driven by a 13 B.H.P. motor running at 1300 to 1600 r.p.m. It is made of gun-metal, is of the vertical spindle type, and has a single impeller. The casing is split along the vertical centre line. A frame of semi-steel carrying the electric driving motor also supports the pump. The shaft is of forged manganese bronze and between the pump and the motor it passes through a silicon aluminium gear-box in which there is a pair of spiral gears driving the exhauster.

The driving motor is spigotted on the top of the frame support, the two half couplings are spigotted together to ensure alignment, and the pump casing is also spigotted on to the lower part of the frame. In order that the whole pump may be dismantled without breaking the suction or delivery pipes, or disturbing the motor, it is arranged that when the four coupling bolts have been removed the pump spindle can drop far enough to clear the coupling spigot. The makers claim that dismantling can be completed in 30 minutes without disturbing the piping or the motor.

The pump is hydraulically balanced, but as a safeguard there is fitted at the top of the motor casing a thrust bearing. Encased in a gun-metal housing at the bottom of the pump there is a lignum vitæ bearing. The gland at the top of the pump is of the split type, and is readily removable. It is lubricated through a special type of lantern neck ring, while a grease lubricator is also fitted.

The exhauster fitted to the pump is of particular interest. A sectional drawing is given in Fig. 28. It will be seen that it consists of a rotor having a number of radial vanes rotating in a casing partially filled with water. Rotation of the rotor causes the water to flow round also, and owing to centrifugal force it is constrained to lie in a ring against the casing. In consequence, the rotor is turning excen-

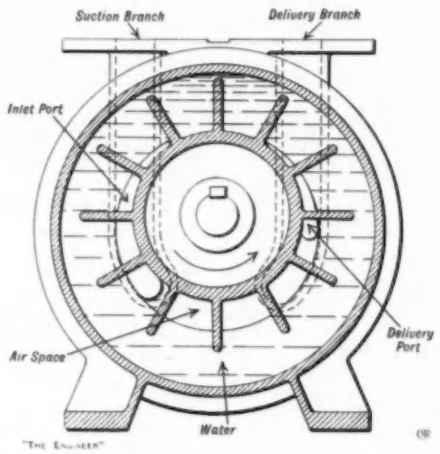


FIG. 28—SECTIONAL DRAWING OF EXHAUSTER—PULSOMETER

trically in what might be called a fluid casing, and it will easily be seen that with the ports arranged as shown in the drawing air must be sucked in at one side, and subsequently compressed and delivered at the other. As both the suction and delivery branches are arranged at the top, it is obvious that the exhauster must always retain sufficient water to operate unless it is left standing long enough for the water to evaporate away. In the suction pipe of the exhauster, which is connected to the highest point of the suction of the main pump through a strainer box, there is a small back-pressure valve fitted for the purpose of preventing the vacuum in the main suction pipe withdrawing the water from the exhauster if the latter is stopped whilst the pump is running.

As we have noted before, the exhauster is driven from the main spindle by means of spiral gears. A friction clutch is also included in the drive, so that the device can be thrown into or out of action at will. The makers claim that this hand control brings about a great saving of wear. In order, however, that the exhauster shall be capable of running for long periods without harm, arrangements are made for a small stream of water always to run through it for cooling purposes.

The makers claim that for a given duty this 5in. marine pump is lighter than any other self-priming pump, and has fewer wearing parts, and that it has drawn on test water against a vacuum equal to 29ft. static suction lift.

In addition to the marine pump, the firm is also exhibiting the Pulsometer steam pump, the Stereophagus sewage pump, and an ordinary general service type pump with a horizontally split casing, a refrigeration plant similar to that recently installed on a vessel of about 2500 tons, and various types of sirens.

AEROSTYLE.

Perhaps the most interesting of the exhibits of Aerostyle, Ltd., of St. John-street, E.C. 1., is the petrol engine driven portable spraying plant, of which we reproduce a photograph in Fig. 29. This plant can be used with the spray gun, bowl and tubing shown in the illustration, or it can be adapted for larger work. The engine is a Villiers 147 c.cm. two-stroke, with a bore of 55 mm. and a stroke of 62 mm., giving 1½ H.P. at 2500 r.p.m. As can be seen from the illustration, both the engine and compressor cylinders are provided with adequate fins for air-cooling purposes, while a specially designed centrifugal fan with a closely fitting cowl is also installed to assist the flow of air round the cylinders. Fuel is supplied from the tank above, which carries both petrol and oil.

The air compressor cylinder is placed in line with that of the engine on the side furthest from the handles used

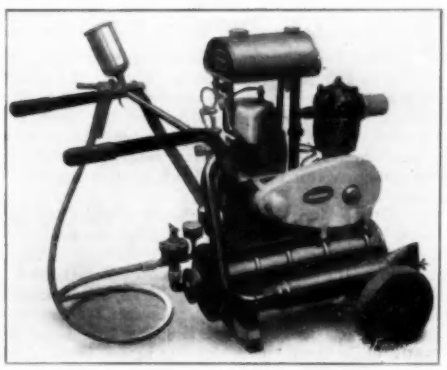


FIG. 29—PETROL ENGINE DRIVEN PORTABLE SPRAYING PLANT—AEROSTYLE

for transporting the unit. It is driven by means of a roller chain, which is enclosed under a cover. Use is made of the compressor shaft for starting purposes. The valve mechanism of the compressor is totally enclosed, but at the same time has been made readily accessible. The valves themselves are arranged to have as small a lift as possible compatible with free air flow. They are made of special steel and seat upon phosphor bronze seatings. A filter consisting of copper spinnings covered with fine copper gauze is fitted in the air intake. For the purpose of facilitating starting, a hand unloader is provided upon the domed head of the compressor cylinder.

The air receiver is placed below the engine and the compressor. It is 2ft. long by 8in. in diameter, and is made of welded steel. It is capable of standing a pressure of 250 lb. per square inch safely. A safety valve and a pressure gauge are fitted, and there is a drain cock for removing moisture. Besides supporting the engine and compressor, the receiver forms part of the undercarriage. It is supported at one end upon a forged steel axle. Roller bearing, rubber-tired wheels are fitted. At the other end of the receiver a forged steel support is provided. The outlet to the spraying apparatus is provided with a filter of a type similar to that fitted to the inlet to the compressor.

When running at full output the compressor is capable of delivering about 8 cubic feet of free air per minute, and the makers state that approximately 8 hours' running can be obtained for a petrol consumption of 1 gallon.

Besides the portable set just described, Aerostyle, Ltd., is showing many other types of portable spraying outfits suitable for work of various kinds.

THE SELSON ENGINEERING COMPANY, LTD.

On the stand of the Selson Engineering Company, Ltd., of 26, Charles-street, E.C., machine tools made by a number of manufacturers are shown. In Fig. 30 we reproduce a photograph showing an automatic cutter head grinder in action. This machine is constructed by Collet and Engelhard. It will automatically grind all cutting angles of inserted blade milling cutters on the face, side and chamfered edge, and is also capable

of grinding spiral fluted cutters and the cutting face of involute gear cutters. It will be seen from the illustration that the controls, the driving motor switches and starter are all built into the body of the machine. Sliding surfaces are arranged to be always covered. A gear-box is incorporated in the design, which gives two speeds, so that both large and small cutters may be ground efficiently, while a reverse gear mechanism in the spindle head enables the dividing action to be set for either right or left-hand cutters. The grinding wheel itself is fitted to the spindle of an enclosed ventilated electric motor, and is covered by a guard. For the circulation of the lubricant a small submerged vertical spindle centrifugal pump is

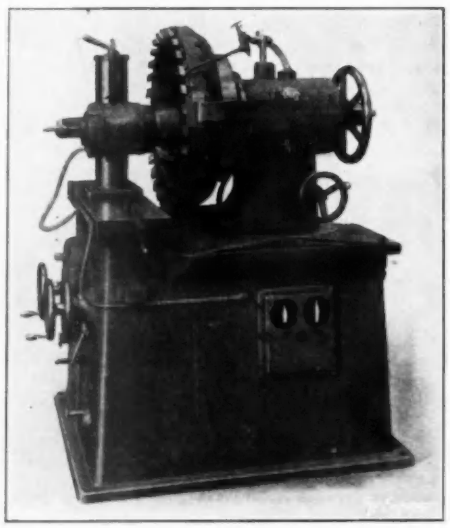


FIG. 30—AUTOMATIC CUTTER HEAD GRINDER—SELSON

fitted in the tank in the base of the machine. The cutter to be ground is fixed on an arbor in the spindle head and adjustment of the machine to provide the correct cutting angles is achieved by means of graduated scales, while the stroke of the grinding slide and the adjustment of the dividing for different blade spacings can be altered whilst the machine is running.

The illustration, Fig. 31, shows a universal production lathe of neat design, made by the same firm. It is capable of machining articles up to 12in. in length and 4½in. in diameter. Strongly constructed, as it is, the makers claim that it is able to use tungsten-carbide tools with advantage. As can be seen from the illustration the base of the machine is of box section, while the electric driving motor is built into the side. The base forms a tray upon which the bed of the lathe is mounted. The electric motor drives through gears and a worm and wheel arrangement

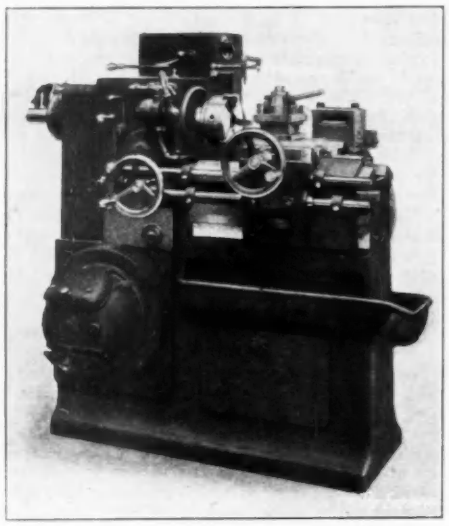


FIG. 31—UNIVERSAL PRODUCTION LATHE—SELSON

and a multi-disc clutch is incorporated for starting and stopping the machine. A brake is fitted for bringing the spindle to rest. When direct current is available, a variable-speed motor is used, but for use with A.C. a three-speed gear-box is incorporated in the design. Adjustable stops are provided to make the machine semi-automatic, and a rapid return traverse mechanism is provided which also withdraws the tool from the work, so that the finished surface of the job is not damaged. The slide carries a turret for four tools, and can be rapidly swung into position and locked by the use of a single lever. The rear tool rest being used only for infeeding is adjustable along the bed by hand. Among the refinements added to this machine are a pneumatic chuck operated by a lever mounted on the headstock and a change feed lever, operation of which immediately reduces all feeds by one-half. The machine weighs approximately 16 cwt. The driving motor, which runs at 1420 to 2840 r.p.m., is of 5½ H.P., and the feeds of the front slide, of which there are eight, provide a range between four-thousandths and eighty-thousandths of an inch. The height of centres is 5in.

The machine illustrated in Figs. XIV. and XV., made by the Cleveland Automatic Machine Company, is an automatic multi-spindle bar machine. Improvements have been made in the bed design of this machine, and it now has great rigidity to suit the cutting power, while a large chip space is also provided for. The machine illustrated is driven directly by an electric motor. A clutch mechanism throws the machine into or out of connection with the power unit, and spindle change gears are provided to give a large range of speed. The machine has two cam shafts made from alloy steel. The upper one carries the worm wheel, combination reaming and threading drum, turret and cross-slide drums, and the disc and cam to operate the top slide and the lower the gauge stop disc, indexing arm, chuck and stock feed drums. The latter is driven from the upper shaft by gearing. The tool turret is cylindrical in form, made from a high-grade semi-steel casting, and moves backward and forward in the wide bearing of the turret housing. The spindle and tool turret housings are cast integrally with the bed casting to ensure alignment. Four extra tool positions can be obtained for end tools by means of the square turret attachment to be seen in the illustrations.

A precision grinding machine made by Naxos-Union, is shown in the photograph reproduced in Fig 32. It is intended for grinding matrices, dies, rules, packing-up blocks, &c., and is designed with a view to its use as a mass production machine. It is supported upon a strongly ribbed bed, which also forms the tank for the cooling water supplied to the grinding point by means of a centrifugal pump. The work table is driven hydraulically by oil pressure, maintained by a pump, which forces the oil through a control valve into a long cylinder, the piston-rod of which is connected to the table. A lever at the front of the machine placed in a position convenient to the operator enables the feed to be altered at will. The upright, which is supported upon the bed at three points, can be adjusted by graduated screws. A vertical electric motor is arranged to slide on the upright and drives the grinding wheel directly. The feed of the wheel can be by hand or automatic. In the latter case, it is operated hydraulically at each reversal of the table. It is engaged and disengaged at the grinding wheel head. The hand wheel at the front of the machine controls the hand feed. The machine is capable of grinding work 39¼in. long, 10¼in. wide, and 11in. high, and the power of the grinding wheel motor is 15 H.P.

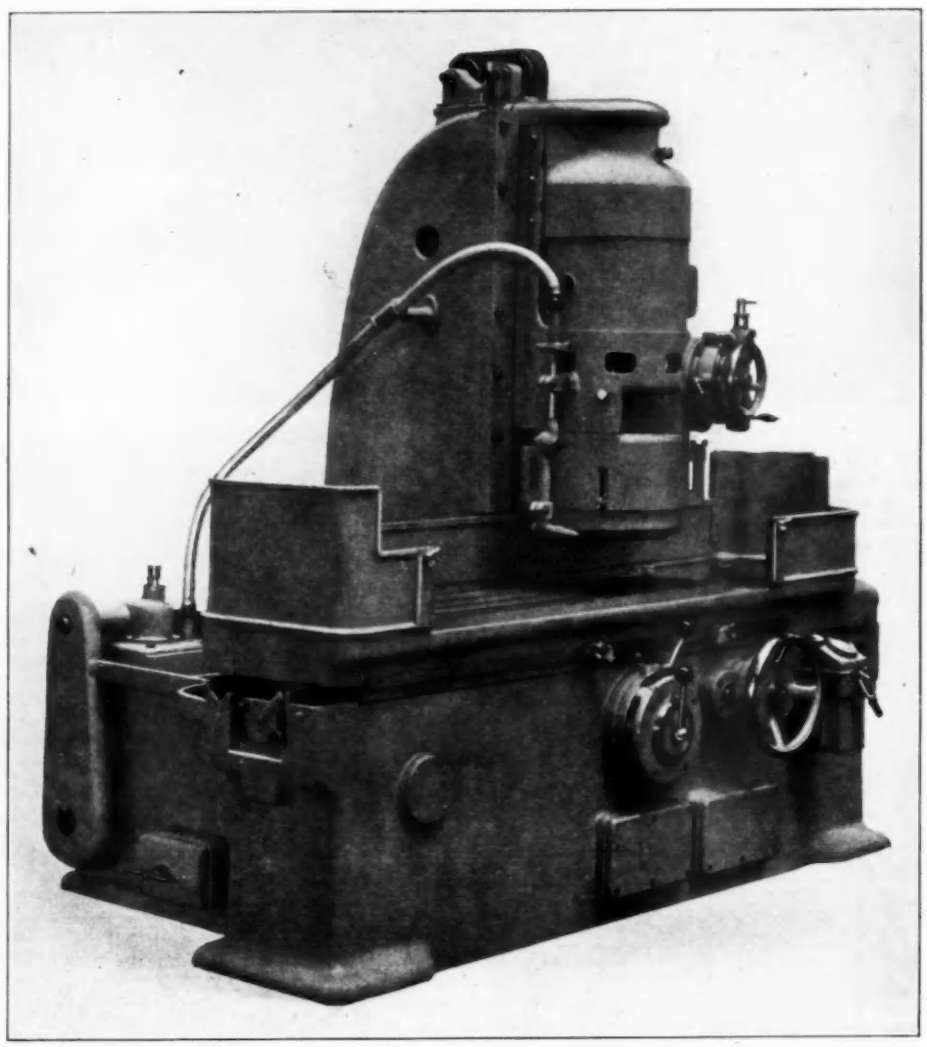


FIG. 32—NAXOS-UNION PRECISION GRINDING MACHINE—SELSON

THE SUNDERLAND FORGE AND ENGINEERING COMPANY, LTD.

Among other products for the electrical equipment of ships, the Sunderland Forge and Engineering Company, of 60, Fenchurch-street, E.C. 3, shows a 3-ton electric cargo winch, Fig. V. in the second Supplement. The winch is equipped with a water-tight motor which develops 28 B.H.P. at the low speed of 275 r.p.m. when the winch is lifting 3 tons at 100ft. per minute. The contactor control gear is in the form of a separate panel, which can be mounted under cover in the nearest wheel house and is designed to increase the speed automatically as the load diminishes. With 1½ tons load the speed of the hoist is 200ft. per minute, whilst with a light hook it is 400ft. per minute. In the design of the winch every endeavour has been made to make it compact in order to economise deck space. Another 3-ton worm-geared winch has "built-in" control gear and forms a self-contained unit. Like the winch with the separate control panel, it is shown in operation. There are four steam generating sets, each comprising a single-cylinder engine directly coupled to a compound-wound multipolar dynamo; also examples of the firm's marine type motors—see Fig. IV. In the construction of these machines special attention is paid to vibrationless running, and the armature is carefully balanced. Moreover, in order to protect the windings against the effects of sea air, they are impregnated by a special process. Two of these motors are shown in conjunction with the company's patented "uni-start" control gear, which avoids the use of a starter for each motor. There are examples of the firm's marine type control gear, comprising a face-plate starter for motors up to 10 horse-power and a drum type starter for larger powers. Marine type electric light fittings are also exhibited.

ELLIOTT BROTHERS (LONDON), LTD.

Among the exhibits of Elliott Brothers (London), Ltd., of Century Works, Lewisham, are split core current transformers of the clamp and scissor types for measuring the current in an A.C. cable without breaking the circuit. The special features claimed

for these transformers are that they are light and compact; they are wound for a secondary current of 50 milli-ampères at full load and can, therefore, be used with very long leads without affecting the reading of the indicating instrument, which can be calibrated as a voltmeter; the range of the transformer can be changed by a screw, which alters the length of the air gap and, lastly, owing to the presence of this gap errors arising in split core transformers owing to dirt between the closed adjacent parts of the movable core are eliminated. The scissors type

FIG. 33—SCISSORS TYPE CURRENT TRANSFORMER—ELLIOTT

of transformer is shown in Fig. 33 and the clamp type in Fig. 34, both of which are made under the Shotter patent No. 327,837.

The transformers are made for low and high-tension circuits. For use on high-tension circuits, and in cases where the conductors are bare or lightly insulated, a "scissor" type transformer is recommended.

Another interesting exhibit on this stand is the Elliott deflectional frequency indicator shown in Fig. 35. This instrument, which is also made under a Shotter patent, has been designed to meet the need for an accurate and sensitive frequency indicator for use on standard frequency circuits. Owing to its long and open scale, it is particularly suitable for use where accurate control of frequency is required. The instrument is of the induction pattern, employing the principle of resonant circuits, and it is practically free from wave form and temperature errors. The case is approximately 13in. diameter, and the angular deflection of the pointer is approximately 200 deg., one-tenth cycle occupying nearly ¼in. of the scale length. The standard calibration is forty-eight to

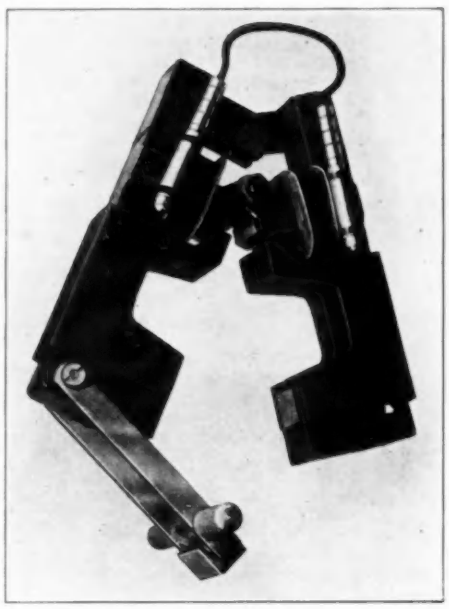


FIG. 34—CLAMP TYPE CURRENT TRANSFORMER—ELLIOTT

fifty-two cycles, and the frequency can be read to one-tenth cycle, and estimated to one-hundredth cycle. Owing to the bold scale and form of the pointer, accurate readings can be taken at a distance.

The instrument is made for pressures of 110, 220 and 440 volts, but can be used on higher voltage circuits if a transformer is employed. The V.A. consumption is 12 to 16, the power factor of the instrument being approximately 0·4.

The Multipen recorder—see Figs. 36 and 37—records the actual time of occurrence or duration of events, and has many applications. It can be used, for example, for recording the time of opening and shutting of valves, switches, gates and doors, &c.; the duration of machine operations; the time of flight of shells; automatic telephone operation, &c. As will be gathered from Figs. 36 and 37, a number of pen units are arranged to draw parallel lines on a moving band of paper, which is driven forward by a spring-operated clock at speeds up to 12in. per hour. For specially rapid operations, a mechanism is employed which gives chart speeds up to 6in. per minute, and, if desired, double or

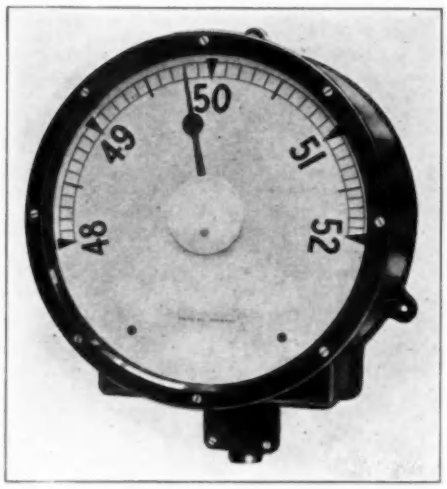


FIG. 35—FREQUENCY INDICATOR—ELLIOTT

quadruple chart speeds can be arranged for. The pens are operated by small electro-magnets, and when the circuit of any magnet is completed, the corresponding pen is deflected, thereby making a short side line on the paper. In the deflected position, however, the pen is not in contact with the armature of the electro-magnet, and the instrument can, therefore, be worked by A.C. without fear of the pen chattering.

The pen units are interchangeable, and any pen or complete pen unit—as shown in Fig. 38—may be removed for repair. The pens may be either of the individually inked pattern, enabling different coloured inks to be employed, or they may all be of the syphon tube pattern, the ink being contained in a separate reservoir with a practically unlimited supply of ink.

IMPERIAL CHEMICAL INDUSTRIES, LTD.

The subsidiary companies of Imperial Chemical Industries, Ltd.—Allen Everitt and Sons, of Smethwick, Elliotts Metal Company, Ltd., Muntz's Metal Company, and Grice, Grice and Sons, are exhibiting for the most part metal tubes for use in land and marine engineering. To exemplify the care with which these tubes are made various microscopic and other laboratory testing devices are shown. A comparison is made in one of the exhibits between the corrosive properties of the super-nickel tubes made by Messrs. Allen Everitt and tubes of other compositions. The tubes are stated to have been in use under the same working conditions. The claim is made for the group of companies that they have supplied the condenser tubes of every ship afloat of

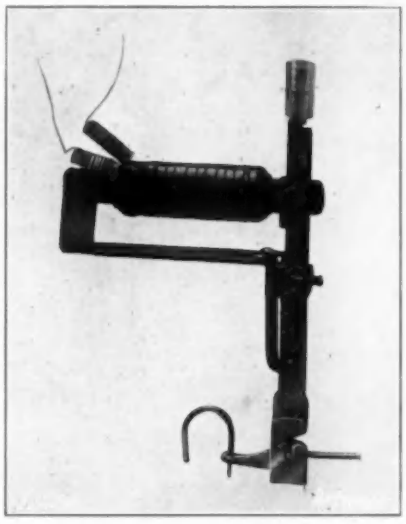
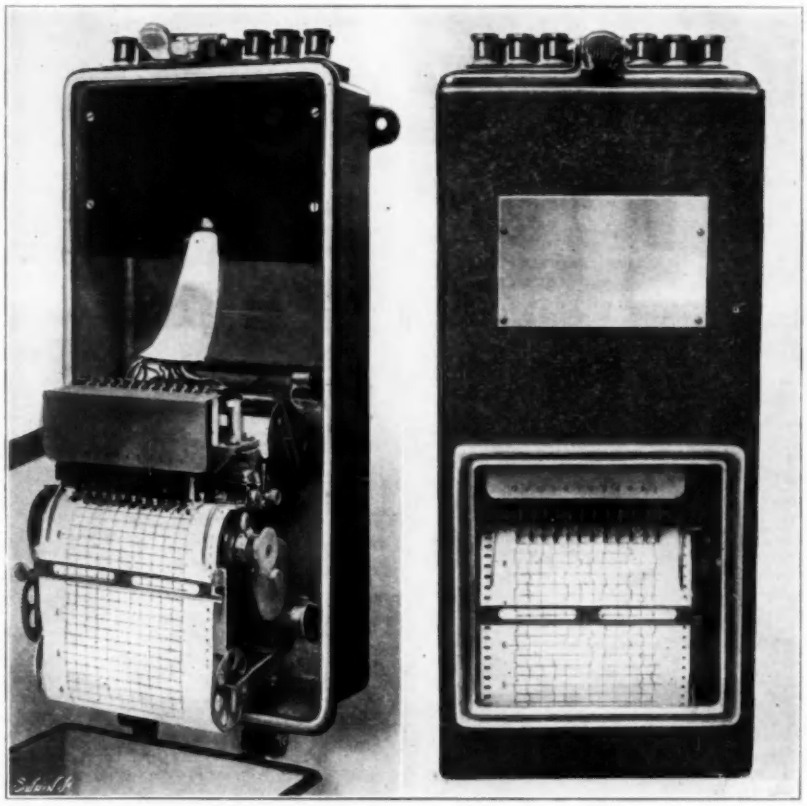


FIG. 38—PEN UNIT OF MULTIPEN RECORDER—ELLIOTT

30,000 tons and over, including the latest German liners "Bremen" and "Europa." With the object of indicating the scope of the companies' activities, the stand is also adorned by two effective dioramas, of which one shows models of various vessels and the other the various types of buildings, power stations, &c., in which the company's tubes have been used. Lengths of copper tubes similar to those supplied to the new buildings of the Bank of England drawn in lengths varying from 50ft. to 200ft. and ultimately cut and bent to the required shape are also to be seen.

HENRY PELS.

Heavy-duty shears, presses, punches, &c., besides portable machines for the same duties, make up the exhibit of Henry Pels and Co., Ltd., of 32-38, Osnaburgh-street, N.W. 1. Fig. 39 shows a new design of portable splitting shears, punch and notcher, with bar angle and tee bevel cropper. The machine is driven by an electric motor, which draws its current from the accumulators to be seen slung under the trolley.



FIGS. 36 & 37—MULTIPEN RECORDER—ELLIOTT

The fly-wheel runs in ball bearings. The frame, which consists of a single high-tensile steel plate, is amply strong enough to carry the stresses. Shafts, gearing, and all other highly stressed parts are forged in Siemens-Martin steel, the gears being cut from the

solid. The punch can be seen on the left-hand side of the photograph reproduced in Fig. 39. It can be set to work continuously or intermittently, and is controlled by hand or by means of a foot treadle. The punches are interchangeable, and are easily inserted or withdrawn. The shears can be seen on the bottom right-hand side, and are arranged to be capable of cutting plates of any length and width. The holding-down screw, which is situated in front of the shears, can be screwed up sufficiently far to allow one leg of an angle cleat to be trimmed or bevelled. The slide, which moves in an adjustable guide, is properly balanced, and the top and bottom knives are interchangeable.

The notcher is situated above the shears on the right-hand side, and is fitted with square blades, by the use of which either rectangular or V notches can be cut. The cropper, which is to be seen near the centre of the frame, is capable of dealing with rounds,

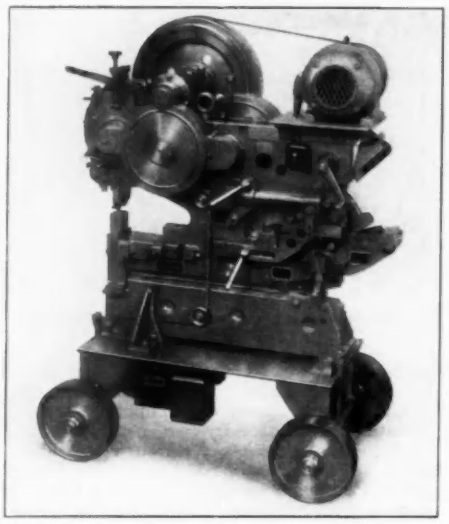


Fig. 39—Combination Portable Shears, Puncher, Cropper & Notcher—Pels

squares, angles, and tees without changing the blades, and by the use of easily attached and suitably shaped blades, joists or channels can be cut. The blades themselves are subdivided with the object of reducing the cost of replacement.

A heavily built shears exhibited on the stand is shown in Fig. XVI. The frame, which is constructed of high-tensile steel, is designed to take up all the shearing strains. It consists of two standards rigidly connected at top and bottom by cross beams. Turned and fitted bolts hold the parts together, but these are subjected to none of the shearing strains. The power to work the shears is transmitted from the fast-moving fly-wheel shaft through heavy gearing to an excentric shaft, which actuates the slide by means of one or more plungers, according to the size of the machine. Particular attention in the design has been devoted to the object of keeping all shafts as short as possible to avoid distortion. Control of the movement of the slide is provided by a strong claw clutch mechanism fixed on the excentric shaft. It is provided with a catch which is designed to ensure full engagement of the claws, and is operated by a treadle. The slide itself is balanced and moves in amply dimensioned box guides. The downholders to be seen in the front of the machine are automatic in action.

The press illustrated in Fig. XVII. is capable of exerting a pressure of 150 tons, has a stroke of 3½in., and provides approximately thirty-six strokes per minute at an expenditure of about 10 H.P. It is one of a range of presses exerting pressures of 100 to 600 tons. The frame is constructed of high-tensile rolled steel plate and takes up all the strains. The power is transmitted from the fly-wheel to an excentric shaft by gearing, and the slide is actuated through cranks. The ram is supported in adjustable guides, and balanced by counterweights. As in the case of the shears, the stop motion is provided by a claw clutch, operated by a treadle or by hand. The clutch disengages automatically at the end of each stroke, and a band friction brake brings the slide to a stop in its highest position.

Brookhirst Switchgear, Ltd.

Representative examples of electric motor control gear, specially designed for engine-room auxiliaries, are exhibited by Brookhirst Switchgear, Ltd., of Chester. The control panel shown in Fig. I. in the second Supplement is suitable for motors up to 100 H.P. The barrel type starter has a ratchet handle, which cuts out the resistance in definite steps. It is interlocked with a no-load and overload release contactor type circuit breaker, which breaks the circuit, and it is impossible to start the motor with part of the resistance cut out at the outset. The control gear is mounted on the front of a slate slab, which is arranged to swing out through the open doorway of the steel case, and as the resistances are mounted on the back of the slab, all parts are accessible. For larger motors the firm supplies a multiple lever starter, which is similar to the drum type, with the exception that the revolving drum carries a series of cams which operate lever switches fitted with contactor type contacts.

The combined starter and speed regulator shown in Fig. II. has been designed for starting and regulating the speed of motors driving fans. It comprises an electrically operated contactor type, double pole, no-volt circuit breaker and a combined series starter and shunt regulator. As it is operated by a key handle, it is impossible for unauthorised people to interfere with the gear, which is also designed to ensure that the motor is started with the full resistance in circuit. A pilot lamp behind a coloured glass disc indicates that the apparatus is in use. For small motors a face plate starter with double-pole switch fuses is supplied or, alternatively, a small drum type starter operated by a crank handle through a notching device and a modified form of no-volt contactor. The apparatus includes the necessary protective and isolating gear for the motor.

The automatic float control gear shown in Fig. 40 has been designed to meet the conditions occurring aboard ship, and gives protection against the wash of water in the supply tanks during the pitching and rolling of the ship. It comprises a water-tight iron-clad float switch with quick make-and-break action, and a 1in. travel of the float is sufficient to move the switch from the "off" to the "on" position. The base plate of the switch carries three stay rods, fixed to a spider casting, whilst the moving float, which operates the switch is guided by a control rod. Any desired length of float travel can be arranged for. As will be gathered from the illustration, the switch and float gear form a combined unit, suitable for fixing to the top of a tank.

The apparatus shown in Fig. 41 is another exhibit, and is described by the makers as the "Pheutrol" patented control device. It has been developed to provide an alternative to float switches or similar devices for use in conjunction with an automatic control panel for starting and stopping electrically driven pumps. It can be mounted in any convenient position away from the tank, and the only part in contact with the liquid to be pumped is a small vertical tube, which is connected to the device shown by a ¼in. copper pipe. Variation in level of the liquid causes a variation in the pressure in the pipe, and this imparts movements to two columns of mercury within the "Pheutrol" apparatus. The operating circuit of the automatic control panel is made and broken according to the level of the mercury at adjustable points in each column, and the pumps are

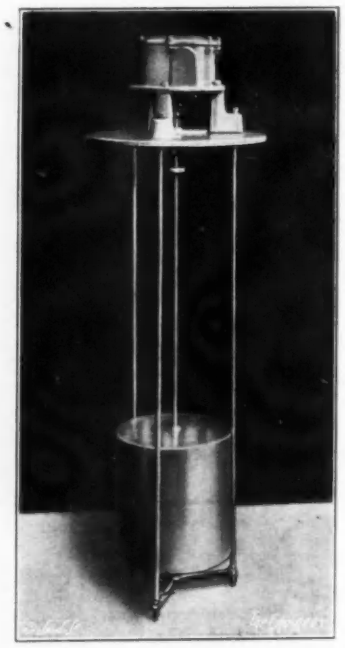


Fig. 40—Float Control Gear—Brookhirst

thus made to start and stop as desired. For the apparatus the following advantages are claimed:—(*a*) There are no external moving parts in contact with the liquid; (*b*) it is unnecessary to place the apparatus in close proximity to the tank, where the atmospheric conditions may be unsuitable; (*c*) as the make-and-break contacts are enclosed in glass tubes, they are unaffected by external conditions; (*d*) the starting and stopping of the pumps are unaffected by the rolling or surging of the liquid in the tank or sump; and (*e*) the apparatus acts definitely under all conditions met with at sea.

Automatic control panels of the solenoid type—see Fig. III.—for operation by a float switch or the "Pheutrol" apparatus comprise a solenoid type automatic starter with carbon-butt type contacts, which engage with a solid copper contact bar fixed to the solenoid plunger. An eddy current retarder ensures slow starting under heavy loads and relatively quick acceleration under light loads. A D.C. contactor type circuit breaker provides no-volt release and a solenoid trip provides protection against overloads. All the starting panels mentioned are steel-clad, and are capable of resisting damp and corrosion.

The firm is also showing an example of its "unistart" apparatus, which involves the use of open type contactor gear mounted on a main switchboard. In accordance with the scheme, a number of motors is controlled by a common starter, but each machine has its own electrically operated contactors, the actual operation of the starter and contactors being controlled in turn by push buttons adjacent to each motor. Shunt regulators, combined with operating

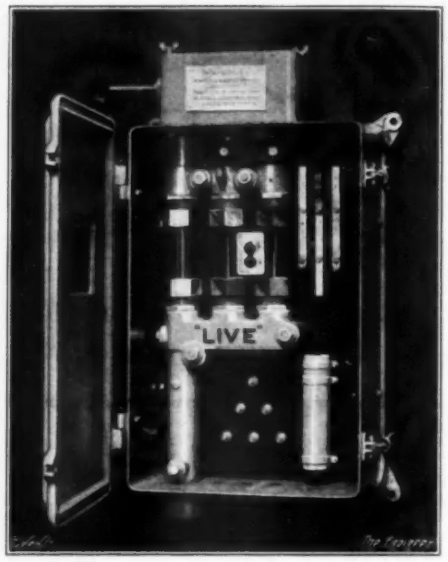


Fig. 41—Pheutrol Control Device—Brookhirst

push buttons, a pilot lamp and ammeter form a convenient and compact type of control station for variable-speed motors.

The Radio Communication Company, Ltd.

The wireless equipment exhibited by the Radio Communication Company, Ltd., of 34–35, Norfolk-street, Strand, has been designed to comply with the recommendations of the 1927 International Radio Telegraph Convention of Washington concerning ships' installations. In order to demonstrate the ease with which the apparatus can be installed on a ship and to give an idea of the space required, the main 1½-kW and ½-kV installations have been placed in ships' cabins. The company's direction finder that is exhibited fully complies with all the requirements of the 1929 Safety of Life at Sea Convention. It consists of a small and easily rotatable frame aerial and a direction finding receiver which is extremely selective and capable of high amplification over a very wide range of wave lengths. One of the advantages of this direction finder is that it can be installed on a ship's bridge without affecting the ship's compass and without obstructing visual observations. The accuracy of the bearings obtained under good working conditions at normal distances and with a reasonably experienced observer is in the neighbourhood of plus or minus 1 deg., and good direction finding reception can be obtained over distances of about 100 miles from a comparatively low-powered coastal station.

International Conventions make it necessary for a continuous wireless watch to be maintained on ships for the purpose of intercepting distress calls. As it is impossible to maintain a continuous watch on ships carrying only one, or perhaps two, operators, the Auto-Alarm has been introduced to meet the requirements of the Conventions and to ensure that a distress call within range of every wireless equipped ship shall receive attention. On the Radio Communication Company's stand an Auto-Alarm is arranged to show how it responds to the distress call and how it is unaffected by interference from other wireless signals. Another important exhibit, which meets international requirements for the safety of life at sea, is a combined wireless transmitter and receiver for ships' lifeboats to enable them to communicate with rescuing ships in the vicinity. The company is also exhibiting a model of the lattice steel masts erected at various stations of the British Broadcasting Corporation. A selection of photographs also illustrates this side of the company's activities.

Wailes Dove Bitumastic, Ltd.

Bitumastic anti-corrosive solutions for the preservation of iron, steel, wood, brick and concrete surfaces, are to be seen on the stand of Wailes Dove Bitumastic, Ltd., of London and Newcastle-on-Tyne. The firm is exhibiting a series of samples of its special Bitumastic enamels for hot application over a priming coat of bitumastic solution, which enamels are largely employed for internal surfaces aboard ship and for steel structures on land. Other materials on view comprise bitumastic coverings for wooden decks

and bituminastic heat-proof cements which have been specially prepared for the protection of boiler-room tank tops in oil-burning vessels. Such cements are light in colour, and therefore give immediate warning of any oil leakage on to the tank top. A similar covering is supplied for the tank tops of coal-burning vessels.

For the protection of the internal surfaces of fresh water and drinking water tanks, the firm supplies a special "Bituros" solution and enamel, which does not, it is claimed, discolour or contaminate in any way the contents of the tank so treated. Other interesting compounds displayed on the stand comprise Bitugrease, a compound specially suited for application to double-bottom, deep tanks and peak tanks, which, on account of their position in the ship, are difficult to dry out. Another anti-corrosive compound is "Bitudensa," a solution for the spraying of condenser tubes of any length. By the use of a special spraying apparatus the solution can be applied without removing the tubes and without affecting the cooling surface. Those who are called upon to deal with fuel and lubricating oils, molasses and spirits, will be interested in the samples of "Picaroid," a preservative material for storage tanks, which is now undergoing exhaustive tests and is being exhibited for the first time.

E. H. JONES (MACHINE TOOLS), LTD.

The machine illustrated in Fig. XIII. is one of a group of milling and grinding machines made by the Werner A.G., to be seen on the stand of E. H. Jones, Ltd., of Britannia Wharf, Islington. This duplex automatic spline shaft grinding machine is a new production, and incorporates a number of interesting features. Two shafts can be mounted

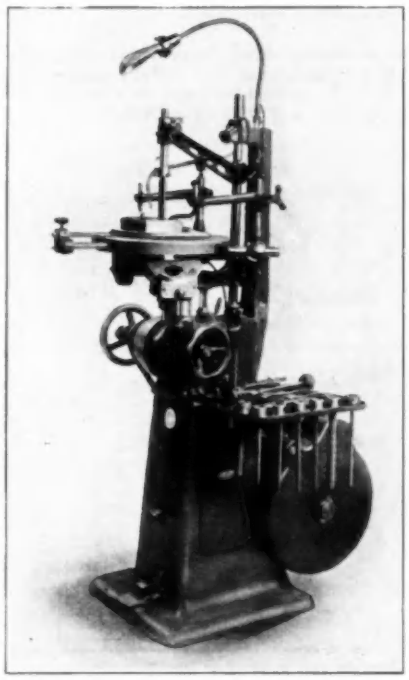


FIG. 42—FILING AND SAWING MACHINE—JONES

together on the machine, and while one is ground on the spline cores the other undergoes the same process on the flanks. The operation can be seen being performed by the machine on a six-spline shaft, 2½in. outside diameter, the length of spline being 10in. The grinding time is given as 8 min. A hydraulic system is used for the operation of the table traverse, the indexing heads and the tail-stocks and electro-magnetic devices are fitted for the feed and locking motions.

The constant improvements that are occurring in manufacturing practice have brought about the demand, not only for more accurate tools, but also for tools capable of doing work formerly done by hand. The machine illustrated in Fig. 42 might be said to be an answer to the second of these demands. This machine is designed for use in the tool-room for filing and sawing, and the makers claim that in the latter operation a line can be followed to within $^1/_{64}$in., so that very little material is left to be removed by the file. The machine is driven by an electric motor through gears, the stroke being easily adjusted by means of a hand wheel. The table can be tilted up to 15 deg. in four directions. The saws used can be of the strip or coil variety, and files of various types, some of which are gripped at top and bottom with a small tension applied, and others of which are held in a ring at the top and kept in position by a centre at the bottom, can be used.

A variety of other machines, including a gear-hobbing machine, lathes, face grinding machines and drills, and devices for checking the sizes of parts accurately, are also shown.

FESCOL, LTD.

The firm of Fescol, Ltd., of 101, Grosvenor-road, S.W. 1, specialises in processes for the electro-chemical deposition of metals. Although primarily metals deposited in this way are applied with the object of preventing corrosion of the basis metal, the process is also used for building up worn parts to their original dimensions. On the stand a number of engineering parts to which the Fescol process has been applied are shown to illustrate the variety of designs that can be dealt with.

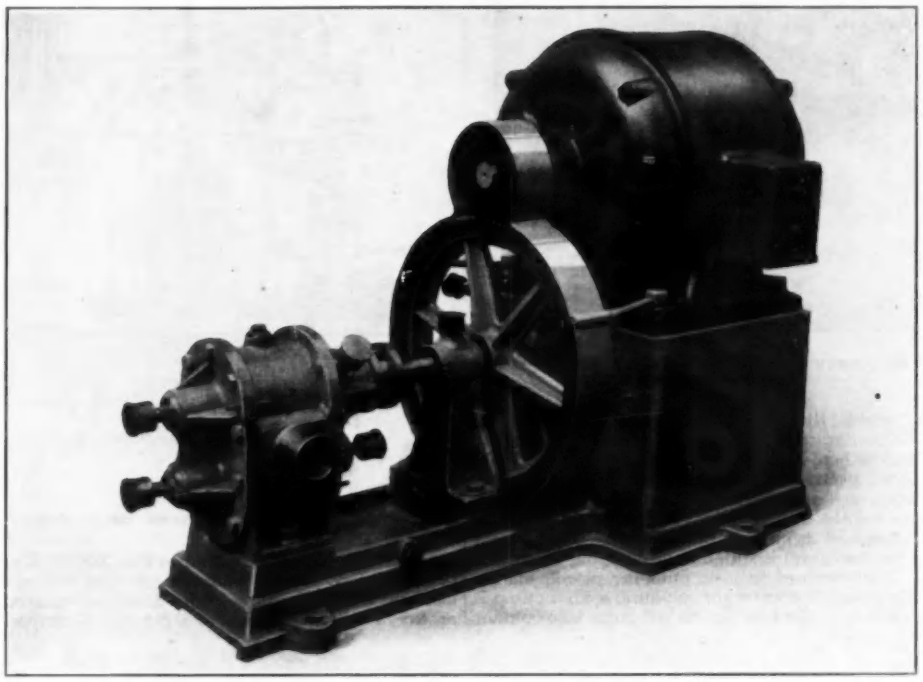


FIG. 43—MOTOR-DRIVEN GEAR PUMP—SALAMAN HANDOLL

The firm undertakes the deposition of a number of metals, each of which is particularly suitable for certain conditions. Nickel is used for building up worn parts and provides a good protection against corrosion, while chromium makes a hard bearing surface material, and on account of its very good resistance to atmospheric effects is very suitable for decorative purposes. Lead can be deposited to afford protection from the action of sulphuric acid, while cadmium is resistant to the action of sea water. Copper can also be deposited.

As the process takes place in the cold there is little risk of any distortion occurring. A skin about 20 mils thick is a usual depth of nickel deposit where protection only is to be afforded, and in the case of chromium this figure can be reduced to as little as 3 mils. But where a worn part is to be built up the thickness of the deposit naturally depends upon the amount of wear that has taken place. Usually such parts are machined to an even surface, and all scores or other marks removed before deposition of the new metal is started. Machining of the parts after deposition has been effected is said to be a somewhat specialised matter, and the firm is ready to undertake this operation. The variety of parts that can be treated is best seen by a visit to the firm's stand, but we can mention reduction gear shafts built up to their original dimensions with nickel, propeller blades protected by means of a coating of the same material, pump impellers and shafts which can be protected with nickel or chromium, the second metal being the most suitable where abrasion may take place, and turbine blades, crank shafts, armature shafts, and many other parts. A particular application of the process occurs in connection with electrical plant. Copper to nickel or nickel to nickel contacts, it is claimed, have a considerably longer life than plain copper to copper. Such parts are also shown on the stand. The great merit claimed for the Fescol process is the strong adhesion between the deposited metal and the part on which it is deposited.

SALAMAN HANDOLL, LTD.

The firm of Salaman Handoll, Ltd., of Albany Works, Ossory-road, S.E., is showing a range of gear pumps. In Fig. 43 we reproduce a photograph of a set suitable for general heavy duties. The gear pump is driven by a motor, in this case of the A.C. type, through gearing. The complete set is mounted upon a strong base-plate and the large gear wheel is provided with two bearings to ensure rigidity and quiet running. The various bearings within the pump

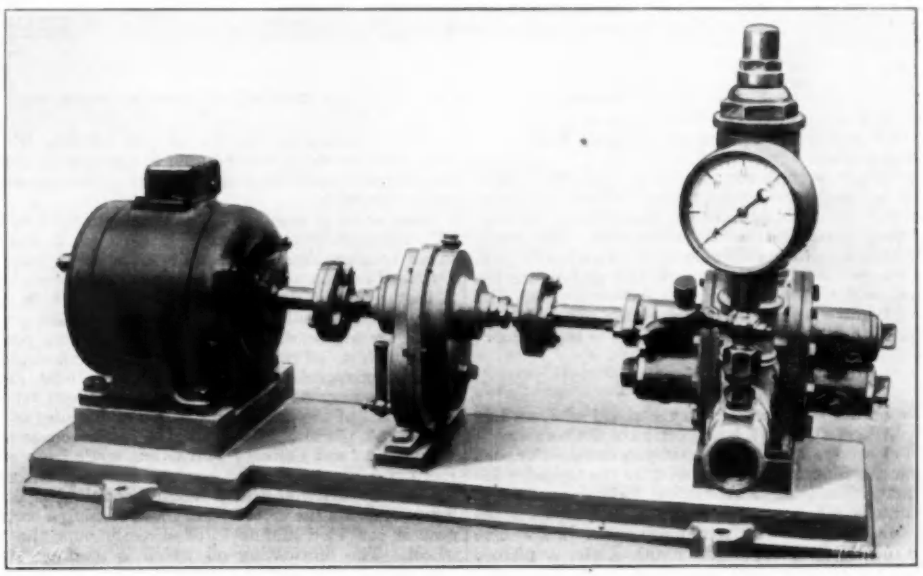


FIG. 44—MOTOR-DRIVEN GEAR PUMP FOR USE WITH PETROL—SALAMAN HANDOLL

casing are lubricated by the greasers to be seen on the outside. This range of pumps is made in capacities from 90 to 50,000 gallons of water pumped per hour. The pump illustrated in Fig. 45 is similar to that described above, but in order to take up the strains incidental to the heavy service to which it may be subjected back gears are fitted.

All types of gear pump made by the firm consist of

two involute pinions revolving in a closed chamber. The manufacturers claim that slip and leakage have been eliminated by the introduction of grooves cut along the tops and sides of the teeth. The action of the grooves is to form a fluid seal, even when the teeth have become worn after long service. The pumps can draw water against a suction head of 28ft., and starting from rest need no priming. The standard delivery pressure head is 300ft., but greater pressures can be obtained if necessary. The standard materials

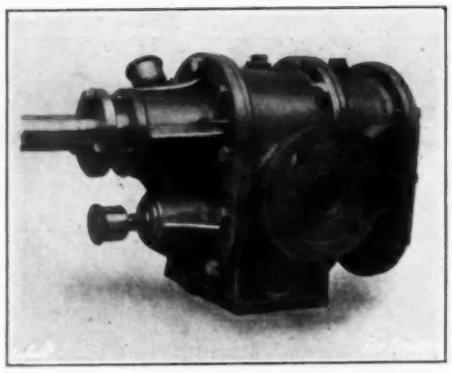


FIG. 45—HEAVY DUTY PUMP WITH BACK GEARS—SALAMAN HANDOLL

from which the pumps are made are gun-metal for the bodies, covers, and impellers, and steel for the shafts. Where back gears are fitted they are usually made of gun-metal. Where conditions of service, however, suggest their use, other metals can be used. Pumps suitable for a variety of purposes are shown. The standard type has plain bearings in contact with the fluid, and is suitable for pumping water and oils. For purposes such as pumping petrol, ammoniacal liquors, hot water, or sulphuric acid, a pump is made in which the bearings do not come into contact with the fluid, while on the heavy type the back gears also are remote.

In the photograph reproduced in Fig. 44 a special pump designed for use with petrol is shown, the drive from the electric motor being through an enclosed gear-box, made also by the same firm. The pump itself is fitted with an outside relief valve and a pressure gauge. Special features of the design are the glands, which it is claimed are so constructed that petrol leakage is entirely absent, while the peripheral speed of the rotors is such that there is no tendency for the petrol to vaporise.

J. AND E. HALL, LTD.

The outstanding exhibit on the stand of J. and E. Hall, Ltd., of Dartford, is a selection of the component parts of a large high-speed ammonia compressor, one of four machines recently ordered by the Grimsby Ice Company, Ltd., of Fish Dock, Grimsby. These machines are believed to be the largest compressors ever ordered for the manufacture of ice. The parts exhibited include the crank shaft, a piston, and its connecting-rod assembled complete, and a delivery valve with its assembly. The makers have kindly placed at our disposal a drawing of this large compressor, and a view of the first machine on the test bed at Dartford. It will run at a designed speed of 250 r.p.m., the direct-coupled motor having an output of 600 B.H.P. As will be seen from the drawing Fig. 46, the crank shaft and connecting-rods are enclosed in a gas-tight crank case, upon which the compressor cylinders are mounted. The cylinders are lagged with bright steel, which incidentally gives a very effective finish to the machine, as may be judged from Fig. XXIII. This engraving also indicates the crank case design, with the round inspection doors fitted to give access to the working parts. The strong ribbing of the crank case and the cylinder jackets and heads may be seen from

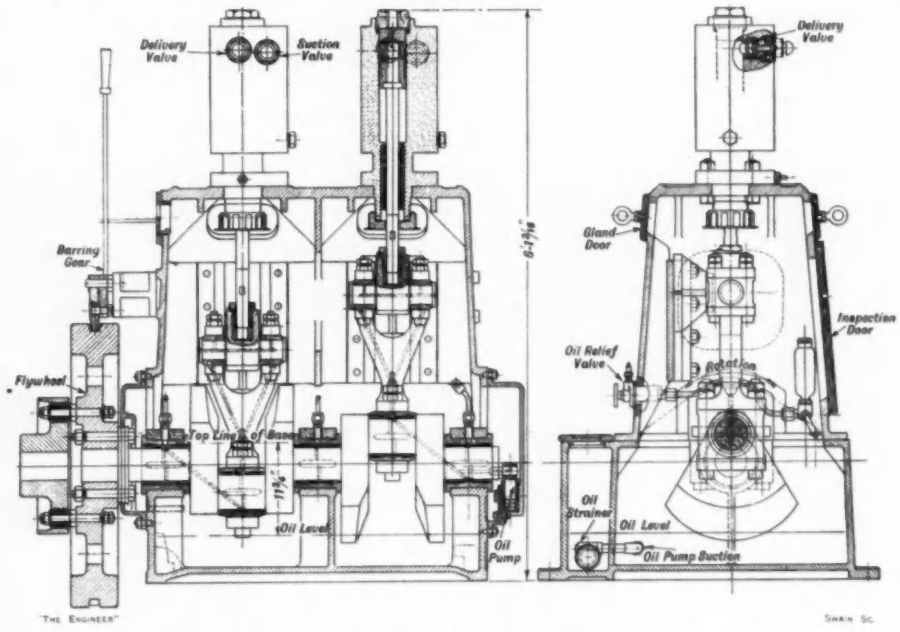


FIG. 47—SECTIONS OF A TWIN-CYLINDER VERTICAL COMPRESSOR—HALL

drawing Fig. 46. With regard to Fig. XXIII, it may be stated that the oil separator near the end of the machine is not the separator for that particular compressor, which is a vertical one, but only a temporary horizontal separator used for test bed service. Those who visit the stand will be able to examine in detail the construction of the pistons and the delivery valves and other parts.

Another large machine is the twin-cylinder vertical CO_2 compressor shown in Fig. 47. It is similar in its construction to two units now being built at Dartford for the new Cunard liner refrigerating plant. A feature of the design of this machine is the generously proportioned main bearings and running parts, which are arranged for forced lubrication, the pump, along with an oil relief valve, air vessel, and strainer, being accommodated within the crank case itself. Attention may be drawn to the gland doors on the upper part of the crank case, which give access to the piston-rod glands. The cylinder blocks containing the suction and delivery valves are made from steel forgings. The compressor has been specially designed for electric driving, and a flexible coupling is fitted between it and the motor. For hand turning a barring gear is provided and is fitted directly over the flywheel. The lubricating oil which is used on these machines is of a special refrigerator quality, and the forced lubrication system and bearing clearances have been specially dimensioned for the use of this particular lubricant.

Smaller refrigerating machines which are now coming to be largely employed for cooling provision rooms aboard ships and for such duties as isolated cold cupboards, drinking water and ice-cream plants, and other domestic services are now in many cases employing methyl-chloride as the refrigerant. We illustrate in Fig. 48 a triple-cylinder "Hallmark" electrically driven machine of this special type with which the cooling effect is provided by a fan are used, and a machine of this pattern may be seen on the stand. As may be gathered from our illustration, the compressor unit with its automatic valve control

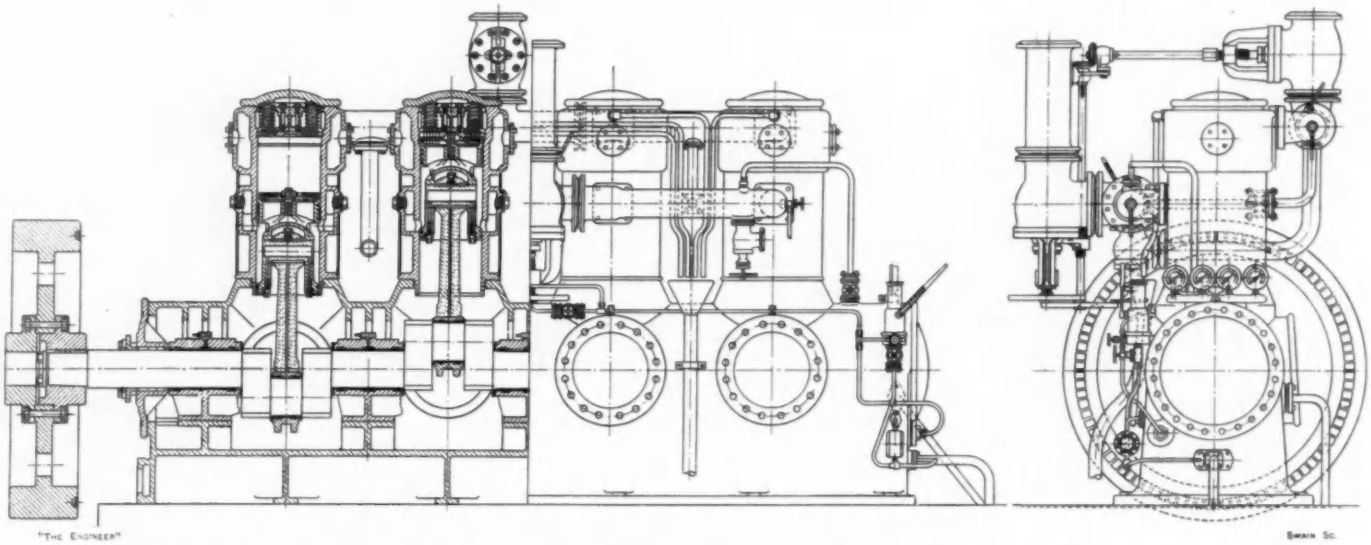


FIG. 46—LONGITUDINAL SECTION AND SIDE AND END ELEVATIONS OF FOUR-CYLINDER AMMONIA COMPRESSOR—HALL

gear is mounted on the top of the base and is belt driven by the motor. The cylinders are furnished with safety heads and the bearing surfaces are made of large area. The machine works on the direct-expansion principle, and the cooler is composed of copper

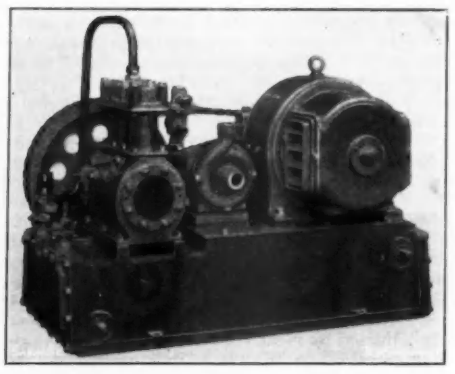


FIG. 48—THREE-CYLINDER, WATER-COOLED METHYL-CHLORIDE COMPRESSOR—HALL

tubes soldered throughout their length to galvanised steel plates. The temperature control is of the thermostatic type and it works in conjunction with an automatic electric control gear. The examples of "Hallmark" methyl-chloride machines shown at Olympia include, besides the triple-cylinder water-cooled

machine already referred to, a larger machine of this same type, a twin-cylinder air-cooled machine, and a steam-driven "Hallmark" compressor. A recent feature of ship equipment has been the introduction of automatic refrigerated cabinets complete with automatic ice-making plant. Two such cabinets are displayed on the stand, each of which has a capacity of about 12 cubic feet. Each cabinet consists of a "Hallmark" compressor with cube ice-making drawers and air-cooled spaces for the cold storage of food and liquids, the temperature being maintained at the desired low level by the plant with its automatic control, which is housed in the base of the cabinet. The external parts of the cabinet are finished in white porcelain so that they can be easily cleaned.

A. G. MUMFORD, LTD., and J. KIRKALDY, LTD.

The joint exhibit of A. G. Mumford, Ltd., of Culver-street Engineering Works, Colchester, and John Kirkaldy, Ltd., is interesting on account of the wide range of marine auxiliaries which are to be seen on the stand. Among the pumps, we have chosen for illustration one of the firm's latest designs, a "Vertex" steam-driven reciprocating pump. The pump itself is of a patented design, which has already been described in our columns, but the method of driving it is new. As Fig. XIX. shows, a rotary piston steam engine built under Anderson's patents is attached to the central column, and is coupled direct to the worm gear driving the pump. As the pump crank shaft itself runs on ball and roller bearings, the drive is a noticeably quiet one. This type of pump is also supplied as an electrically driven unit, with a direct-coupled vertical motor, and a "Vertex" pump of this particular design is also shown. The "Vertex" pumps are supplied in ten sizes, ranging from a 2in. diameter to a 10in. diameter suction, with designed outputs from 1400 up to 68,000 gallons per hour, and with operating speeds from 120 to 50 r.p.m. A 10in. standard vertical centrifugal pump, also driven by an Anderson rotary piston steam engine, is exhibited, and is illustrated in Fig. XX. It has a designed output of about 500 tons per hour.

Particular interest attaches to the rotary piston engine already referred to, and in Fig. 49 we reproduce a sectional drawing of it, which clearly shows the principle on which it operates. The cylinders are carried in a central block, and are arranged in two pairs of four cylinders, one set 45 deg. in advance of the other. Into the cylinder block there is inserted a central sleeve carrying the steam inlet and exhaust passages. The various parts are arranged so that the engine can be quickly opened up for inspection. The central shaft is carried in ball bearings, and is set excentrically to the outer revolving case, which carries the roller path operating the pistons. We show two alternative forms of piston design, both of which have central rollers carried on ball bearings. The engine we have described may be built in either a horizontal or vertical form, and it is suitable for a varied range of speeds up to 1500 r.p.m. The engine is designed to work expansively with a cut off at about one quarter stroke. Its steam consumption varies from 16 lb. to 30 lb. per B.H.P. hour, according to size and to load conditions. The new rotary prime mover we have described was inspected by us running on the test bed, and we found it very silent in operation. It represents an interesting development in marine auxiliary practice. The Mumford patented feed regulator is already familiar to our readers; it being used on practically all the largest liners, and on many naval vessels recently constructed, both in Great Britain and abroad. Particular interest attaches to the regulators, however, for the high-pressure Yarrow type water-tube boilers of the new 70,000-ton Cunard liner now under construction at the Clydebank yard of John Brown and Co., Ltd. These regulators, forty-eight in number, are being supplied by Mumfords, and are made in cast steel and special alloys. A section through one of them and its check valve is given in Fig. 50. Among the exhibits by John Kirkaldy, Ltd., which include a straight tube type exhaust feed heater for either marine or land use, and a compact low-pressure fresh water distiller for use with an evaporator, we have singled out for description the firm's patented electric evaporating and distilling plant, which, it is claimed, is compact and light in weight, incorporating the latest improvements in heating unit designs. This new type of distilling and evaporating plant can be fitted on motor vessels, yachts, or submarines and other vessels, where auxiliary current is available, or it can be equally well adapted for power station use. Our illustration, Fig. 51, indicates the general lay-out of the plant, and the construction of the evaporator. The heaters are of the 5-kW type, and are so arranged that they can easily be removed from the back plate for cleaning. This type of plant is designed in four sizes, with outputs of 90 up to 460 gallons per twenty-four hours.

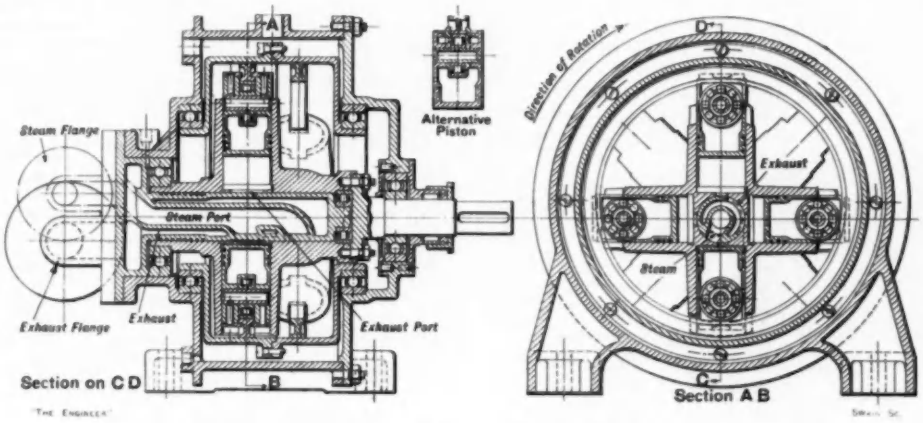


FIG. 49—SECTIONAL DRAWINGS OF ROTARY PISTON STEAM ENGINE—MUMFORD

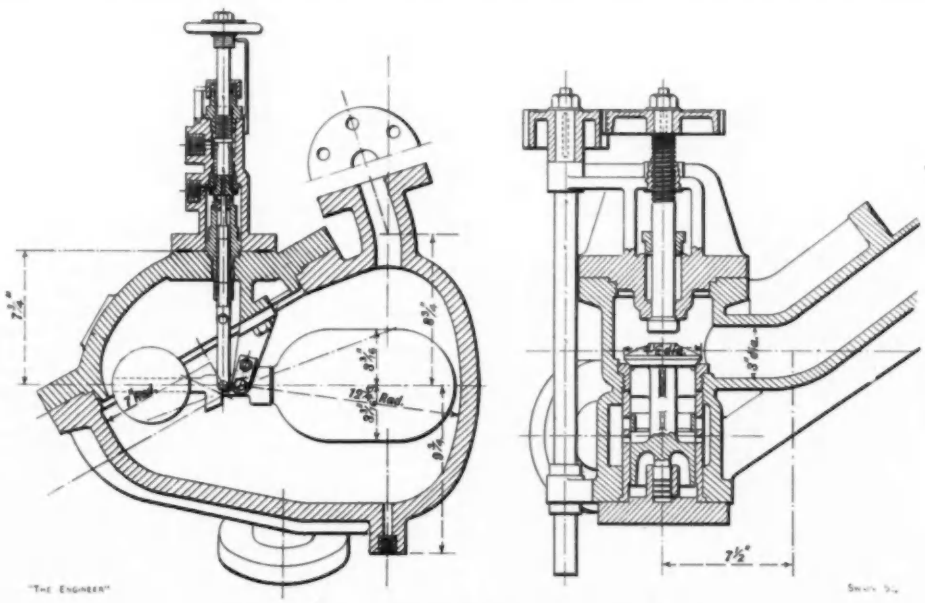


FIG. 50—SECTION THROUGH BOILER FEED REGULATOR

CROSSLEY BROTHERS, LTD.

On the stand of Crossley Brothers, Ltd., examples of large vertical and horizontal oil engines suitable for marine purposes, and a small high-speed type heavy-oil engine, are shown in operation. One of the main exhibits is a marine electric generating set, comprising a three-cylinder vertical compressorless oil engine, having a bore of 12in. and a stroke of 16in., direct-coupled to a Sunderland Forge D.C. compound wound generator, having a designed output of 130 kW, 220/240 volts, at 375 r.p.m. The engine is mounted on a substantial cast iron under base-plate, and makes a compact and readily accessible unit for electric power generation on board ship. A typical view of this type of engine is shown in our illustration, Fig. 52.

The engine has a normal rating of 195 B.H.P., it is cold starting and is designed to burn the cheapest grades of fuel oil, the guaranteed fuel consumption at full and three-quarter loads not exceeding 0·59 lb. per kW-hour. The lubricating oil consumption is about 0·6 pint per engine hour. Thus, with fuel at 80s. per ton, the operating costs for both fuel and lubricating oil works out at less than 0·28d. per unit

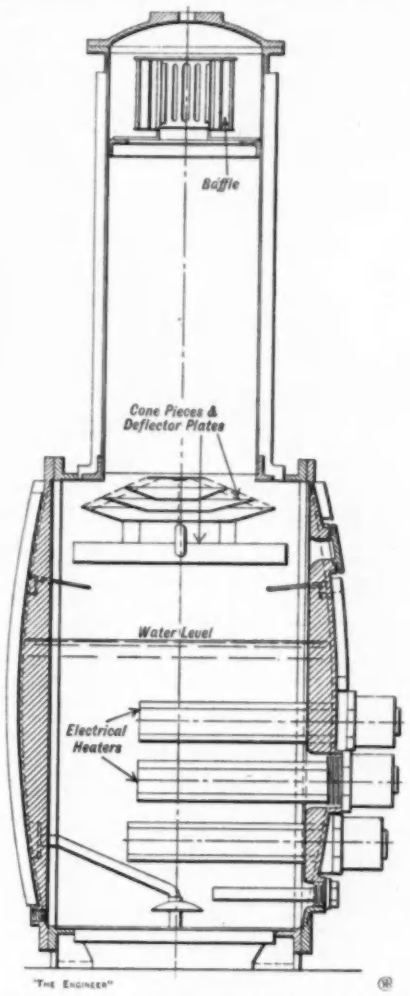


FIG. 51—ELECTRIC EVAPORATING AND DISTILLING PLANT—KIRKALDY

generated. This particular design of Crossley-Diesel engine was introduced some three years ago, and since that time extensive experience has been gained with it both at home and abroad, under marine and land conditions. The type, it is claimed, has fulfilled all expectations, and has proved reliable and economical, while repairs and renewals have been practically negligible. From Fig. 52 it will be seen that the engine is of the totally enclosed type. A feature of the design is that all the moving parts requiring lubrication are supplied from a central pressure system, so that no oil-can is necessary. Although the engine is totally enclosed, immediate access is given to the sprayers, the valves, and the valve gearing by merely sliding back the top aluminium cover plate, which completely exposes these working parts. The framing throughout is both strong and rigid, an essential feature which has resulted in freedom from bearing troubles and liner wear. As shown in Fig. 52, thermometers are provided, one to each exhaust branch, and one to each water outlet branch. The fuel pumps are gear driven, and are grouped together in one compact unit, fixed at the governor end of the engine and affording easy accessibility. The overhead inlet and exhaust valves have each a detachable cage, and they are operated directly by valve levers without the aid of push rods. The cam shaft is likewise arranged overhead, enclosed, and it is driven by means of a silent roller chain with adjusting gear so designed that no disturbance can occur in the valve timings. Compressed air at a pressure of about 250 lb. per square

inch is used for starting, and cam-controlled starting valves are fitted to each cylinder. The engine is furnished with a tachometer, an oil cooler and filter, and a water circulating pump, which are clearly shown in our illustration. A hand-controlled speeder gear is fitted, by which the speed may be set, at will, at any point within a range equal to 10 per cent. of the normal speed.

Referring to the Sunderland Forge generator, the armature of this machine is of the drum type, with a cylindrical winding, the whole core being securely fixed on a substantial cast steel spider keyed on the shaft, the fly-wheel coupling boss being cast solidly with the spider. An outboard bearing of the pedestal type is employed to support the dynamo shaft.

A noteworthy exhibit, illustrated in Fig. XI., is a Crossley-Premier four-cylinder, two-crank, horizontal *vis-à-vis* oil engine, with a normal designed output of 310 B.H.P. at 180 r.p.m. The particular engine shown has been built for the Nelson Line Company, and is similar to ten sets already supplied to that company for direct coupling to ammonia compressors for refrigeration purposes. These engines have been or are being installed in motor vessels of the "Highland Monarch" class. The engine cylinders are 16½in. in diameter with a 24in. stroke. The crank case is totally enclosed with forced lubrication to all main moving parts, and the design has many outstanding features peculiar to the form of construction adopted. In the first place, owing to the short stiff crank shaft, the engine is free from torsional vibration within the operating range, which may be from 70 to 180 r.p.m. In this two-crank engine, the pistons of each pair of *vis-à-vis* cylinders act through their respective connecting-rods, and are coupled to the same crank pin, which has a very large bearing area. They are of special construction with split skirts, and are provided with accurate means of adjustment in order to prevent any lift in the underrunning pistons that might otherwise occur. Forced lubrication is fitted to all main bearings, to big ends and pistons and the exhaust valves. The marked degree of steadiness, when running, obtained from this particular type of engine, has been confirmed by the shipowners after a working experience extending over the past three years. As regards fuel consumption, a figure of 0·385 lb. of Diesel oil per B.H.P. per hour is obtained on regular service. The engine is started from cold by means of compressed air at a pressure of 250 lb. per square inch.

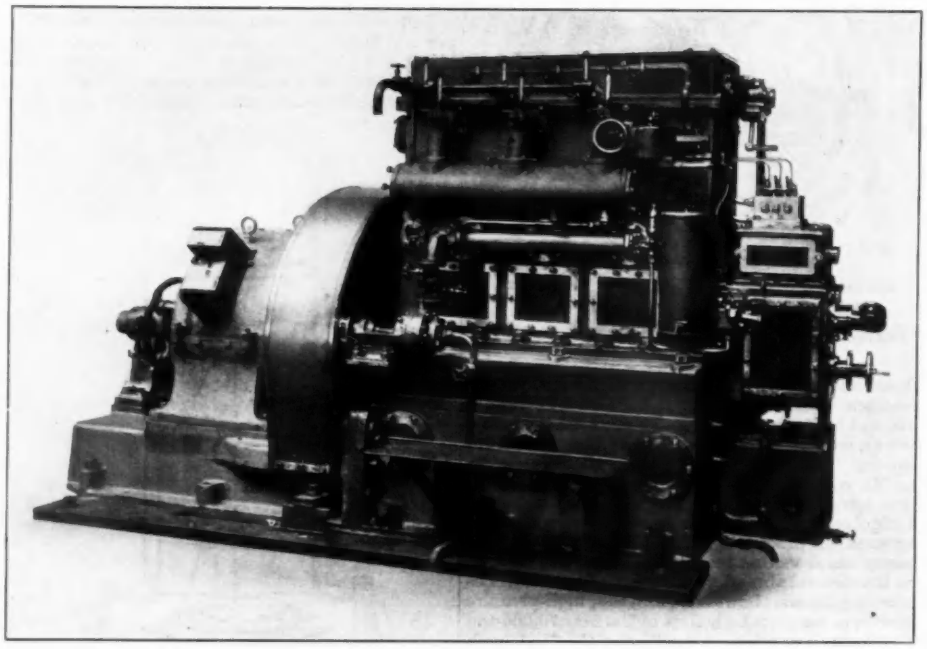


FIG. 52—130 kW OIL ENGINE GENERATING SET—CROSSLEY

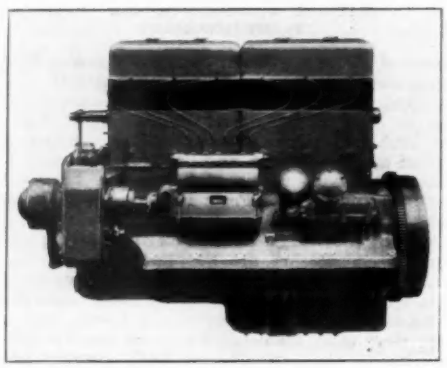


FIG. 53—60-90 B.H.P. HIGH SPEED OIL ENGINE—CROSSLEY

An interesting model of the "Highland Monarch," lent by Mr. A. R. T. Woods, of the Nelson Line Company, is shown. This ship has on board two of these *vis-à-vis* Diesel engines driving ammonia compressors and pumps supplied by the Liverpool Refrigeration Company, Ltd., of Liverpool.

The third working exhibit is the new Crossley high-speed heavy-oil engine, the example shown being illustrated in Fig. 53. It is of the six-cylinder type, and is rated at 60 to 90 B.H.P. at speeds of 1000 to 1800 r.p.m. The cylinder bore is 4½in. and the stroke 6in. This engine is shown in operation on the same Diesel fuel oil as that used on the larger engines, and it is also of the cold-starting type. It may be supplied either for direct coupling to dynamos for pump or compressor driving, or mounted upon an under base-plate. Engines of this type have also been used for commercial vehicles and tractors, the one shown in operation being of the same type and size as the engines which are now being used on Crossley omnibuses. The fuel-operating cost of such vehicles, it is stated, is less than one-quarter that of a petrol engine driven omnibus of the same capacity.

J. AND H. MCLAREN, LTD.

There are several oil engines of the McLaren-Benz type on the stand of J. and H. McLaren, Ltd., of Midland Engine Works, Leeds. They include sets of 180, 90, 30, and 50 brake horse-power, which give those outputs at speeds of 500, 800, 800, and 1400 revolutions per minute respectively. Of these engines we illustrate the largest in Fig. VIII., while the drawing, Fig. 54, gives a section through the cylinder head.

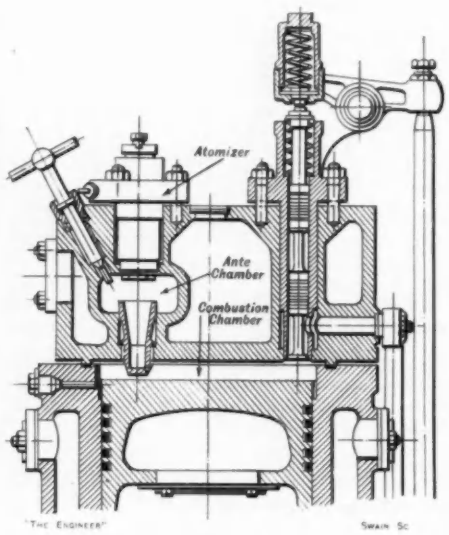


FIG. 54—SECTION THROUGH THE CYLINDER HEAD OF A MCLAREN-BENZ OIL ENGINE

All the engines are of the airless injection four-stroke type. The 180 B.H.P. six-cylinder is directly reversible; the 90 B.H.P. six-cylinder is fitted with a Parsons' 3in. type reverse gear. The hand-starting 30 B.H.P. two-cylinder model is also fitted with a Parsons' reverse gear, the width of tooth in this case being 1¼in. The high-speed 50 B.H.P. four-cylinder engine is of the stationary design. It should be pointed out that all the above engines can be supplied in either stationary or marine types.

The characteristic feature of these engines is their cylinder head, as shown in Fig. 54. Shortly before the piston arrives at its upper dead centre, the fuel is delivered to the atomiser under a pressure of about 1000 lb. per square inch. The fuel needle is lifted and the fuel is sprayed into the ante-chamber, where part of it is ignited and burned, owing to the high temperature of the compressed air. The pressure within the ante-chamber is thus rapidly increased, and the mixture is forced into the main combustion chamber and mixed with the larger volume of compressed air. On its way through the ante-chamber the fuel is transformed into a mixture of oil vapour, burned and unburned oil, the process being similar to that in an oil gas retort. The atomisation is consequently very thorough, and the oil really enters the main combustion chamber in vapour form, which naturally ensures good combustion when it becomes mixed with the compressed air, and there is practically no carbon deposit.

The fuel consumption of these engines is claimed to be not more than 0·5 lb. per B.H.P. hour in the case of the smallest engines and not more than 0·38 lb. in the case of the larger sizes.

We have previously given some account of these engines, so it is unnecessary to enlarge upon their constructional details here. These engines are of four or six cylinders according to the power required, and have a bore of 105 mm. by 150 mm. stroke. The speed is, in each case 1400 r.p.m. and the output 50 and 75 horse-power respectively. The compression pressure is 500 lb. per square inch and the maximum pressure 650 lb. per square inch. A new light model with an aluminium crank case has been developed for such work as driving lorries.

WILLIAM BEARDMORE AND CO., LTD.

A drawing of the high-speed oil engine shown on the stand taken by William Beardmore and Co., Ltd., of London and Glasgow, is given in Fig. 55. Before bringing out this design a large amount of research work was carried out in the works, and observation has been kept of other engines running under service conditions, with the result that a light and strong oil engine has been produced which, it is claimed, will be reliable in service and have a long life.

The engine is illustrated also in Fig. IX. It runs at a maximum speed of 900 r.p.m. and develops 360 B.H.P. It has a bore of 8½in. and a stroke of 12in.

The crank case is a light steel casting. The top part of the casting forms the water jacket around the cylinder liners. The cam shaft is carried in an isolated tunnel cast integrally with the crank case.

The cylinder liners are interchangeable. They are made from steel forgings, machined all over, the bore being ground and the outside surfaces treated to prevent corrosion.

The crank shaft is a special steel forging, machined all over. It is carried in seven adjustable white metalled bronze bearings, adjustment being by shims. The spigoted half-coupling is forged solid with the shaft, the fly-wheel being sandwiched between the half-couplings. The end of the crank shaft remote from the fly-wheel has fitted on it the first wheel of the gear train driving the cam shaft, the chain sprocket wheel driving the circulating water and lubricating oil pumps, and the vibration damper.

The cylinder head is an aluminium alloy casting with steel seats cast in. The inlet and exhaust valves are arranged symmetrically, the fuel valve being situated in the centre of the head, the side walls of which are extended upwards to carry the valve-operating mechanism. A light aluminium cover, easily detached, serves to exclude dirt, &c., from this gear.

The inlet and exhaust valves work in guides pressed into the cylinder head, the exhaust valves being made from special heat-resisting steel. The tappets are of the roller type fitted with hardened steel rollers and pins, a floating bush being interposed between roller and pin. They work in cast iron guides spigoted and studded to the crank case. The tappet guide top is slipped into the push-rod casing formed in the cylinder head and made oil-tight by a rubber joint ring. The valve motion is taken from the tappets to the valve rockers through hollow steel push-rods with hardened steel ball and cup ends, which are pressure lubricated. The rockers are mounted on roller bearings, the rocker fulcrum pins being carried in the upper walls of the cylinder head.

The piston is of the trunk type, die cast in a special heat-treated aluminium alloy. Four gas rings and two scraper rings are fitted.

The cam shaft is hollow and made in one piece from special case-hardening steel, the cam profiles and journals being case-hardened. The shaft is carried in split aluminium bearings placed between each cylinder, a ball bearing at the driving end in front of the gear wheel locating the shaft longitudinally. It is lubricated by means of the hollow centre and holes drilled on the leading face of each cam.

The atomiser is of the "closed" differential spring-loaded needle type. It consists of a stamped steel body with removable C.I. guide and hardened

steel needle, the adjustable spring holding the needle upon a coned seat in the steel nozzle, which is of the multi-hole type. The lifting pressure of the valve can be adjusted and the working parts of the atomiser are brought to a very high finish to ensure accuracy and reliability in operation.

An atomiser vent block is placed on the highest part of the pipe line between the fuel pump and atomiser. This valve allows the operator to clear the system of air, or to cut out a cylinder, all fuel or air thus by-passed passing through the valve to the drain rail.

The main plunger excentric shaft driving the fuel pump is operated through an Oldham coupling from the engine crank shaft. Each pump plunger is made to deliver fuel to two cylinders on alternate strokes by means of a switch valve which reciprocates at half engine speed.

The measurement of fuel and its period of injection is governed by a control valve reciprocating at engine speed in phase with the main plunger. The rotation of the control valve by the governor determines the quantity of fuel delivered to the engine. The time of injection is varied by movement of the control valve in an upward or downward direction relative to the main plunger. This is effected automatically by the governor.

On the top of the fuel pump block a trip gear is fitted which can be operated by means of an emergency governor or by hand. The trip is designed to break the pressure in the pump chamber and by-pass the oil to the collector tank. The fuel pump block and distance piece are mounted on a bracket, which is bolted on to the engine gear case. This bracket is of aluminium, and carries the bearings for mounting the main excentric shaft. It also contains the gearing and shafts for operating the switch and control valves. An outer cover is provided on the bracket, the removal of which facilitates the inspection of the gearing, &c.

The switch and control valves are driven through bronze excentric straps and steel levers coupled to the valves with ball-ended adjustable links. The levers are mounted on fulcrum shafts, that for the control valve being excentric in its bearings and capable of partial rotation to provide for raising or lowering the valve to alter the time of fuel injection. The fuel pump plungers are driven from the main shaft through bronze excentric straps, white metal lined, and steel excentric rods fitted with ball ends.

The governor is of the simple fly-ball type, mounted in the lower portion of the fuel pump bracket. It operates the fuel pump throttle through the medium of a hydraulic relay. When the engine is required to operate over a range of speeds, the governor is provided with a speed control mechanism designed to fix the engine revolutions at the predetermined figures. Thus, speeds of 400, 600, 750, and 900 r.p.m., or any other combination, may be required for a particular duty and the mechanism, which is operated electro-hydraulically, provides for them.

When the engine is required to operate at variable speed a vibration damper of the friction slipper fly-wheel type is mounted on the extreme end of the crank shaft. It consists of a steel centre piece having two "Ferobestos"' discs loosely spigoted to it. The two slipper fly-wheels are mounted on the boss and make pressure contact with the "Ferobestos" discs by means of very stiff helical springs. The discs are free to move relative to either the centre boss or to the fly-wheel. The centre boss of the vibration damper is utilised as a means of driving the main fuel pumps through the medium of an Oldham coupling, two tongues being formed on the centre boss for this purpose.

THE MOND NICKEL COMPANY, LTD.

The stand of the Mond Nickel Company, Ltd., of Imperial Chemical House, S.W. 1, occupies an island site. The alloys of nickel have many applications in the shipping and engineering industries. The company has, therefore, limited its exhibits to applications of some of the better-known alloys.

Nickel silver, for example, is represented by a number of taps for which purpose its soft white colour combined with resistance to soapy fluids makes this alloy particularly suitable. The low nickel nickel-copper alloys could hardly be represented better than by condenser tubes, of which a range of various compositions is shown. These alloys, and particularly that containing 30 per cent. of nickel, have done much to relieve marine engineers of condenser tube trouble. Of the higher nickel nickel-copper alloys, the best known is undoubtedly Monel metal, which here appears in the cast form as pump impellers. Monel metal offers high resistance to both corrosive and erosive effects, and is therefore particularly suitable for this kind of work. The use of nickel-chromium alloys for resisting heat and oxidation is illustrated by heat treatment boxes while malleable nickel cooking utensils, such as are used in ships' galleys, on railway trains and in restaurants, are indicative of the non-toxic qualities and durability of the pure metal itself.

A model galleon, constructed throughout of pure nickel, also demonstrates the many forms in which this material may be obtained and worked.

Turning from the non-ferrous to the ferrous alloys, the value of the addition of nickel to cast iron is shown in a series of sectioned castings, some parts of which are heavy, while others are thin. It will be observed that in spite of the large variations in section, the nickel cast iron has given a fine, even and machinable texture throughout. That the use of nickel cast iron is not limited to small parts, may be seen from cylinder liners over 4ft. in length by 18in. diameter. Evenness and fineness of grain is again remarkably well characterised.

THE RECORD ELECTRICAL COMPANY, LTD.

Ammeters, voltmeters, insulation testing sets, electrical tachometers, and circuit breakers constitute the exhibits of the Record Electrical Company, of Broadheath, Altrincham, Cheshire. The tachometers are made in several types, the instrument shown in Fig. 56 being a single-engine tachometer for aircraft service. Twin and triple aircraft engine tachometers are edgewise instruments. Another circular instrument is made for general purposes, such as for indicating the speed of steam engines, turbines, colliery winding engines, and so forth. Watertight tachometers are supplied for ships, docks, mines, &c. The generator for operating the tachometer illustrated is shown in Figs. 57 and 58. Every indicator and every generator is standardised in order to reduce the stock of spares. In the absence of standardisation, a spare triple edgewise indicator would require a spare generator for each dial, but owing to standardisation one spare generator is sufficient. The individual units of the edgewise type of indicator are also interchangeable. The small and light aircraft tachometer generator, which is enclosed in an aluminium case, is capable of generating sufficient current at an exceptionally high voltage to operate high torque and high-resistance indicators. It is provided with a cobalt steel magnet, in the field of which a multi-pole armature mounted on ball bearings revolves. A nose at the driving end of the machine is threaded to receive a British Standard flexible drive, the armature shaft being connected to the drive by a floating coupling, so that no strains are transmitted to the armature. If it is desired to adapt the equipment for other than British engines, the form of nose can be changed. As will be seen from Fig. 57, a special plug and socket are provided for the electrical connections, the plug being held in position by a spring clip, so that it is impossible for it to become disconnected. As the generators and indicators are screened, they are not affected by the presence of masses of iron or steel near them.

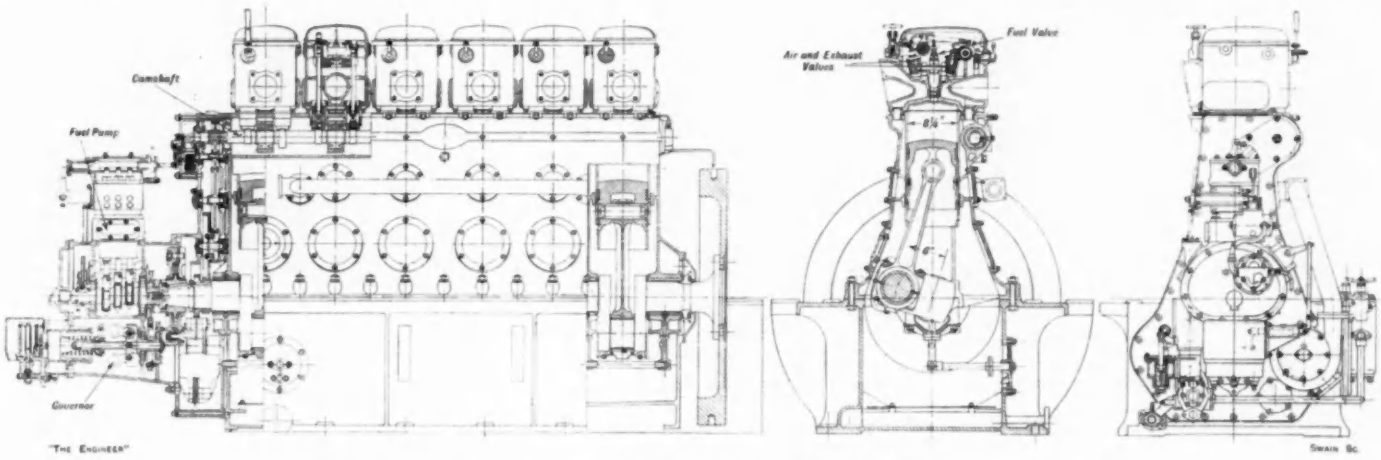


FIG. 55 SECTIONAL DRAWINGS OF A 360 B.H.P. HIGH SPEED OIL ENGINE—BEARDMORE

FIG. 56—AIRCRAFT TACHOMETER—RECORD

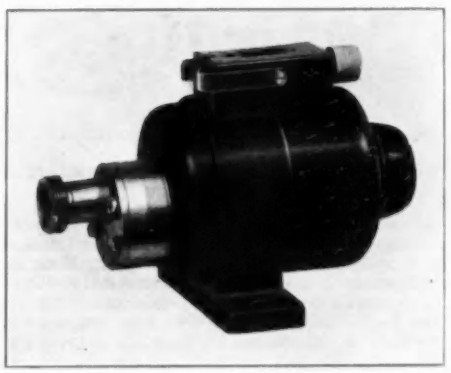


FIG. 57—TACHOMETER GENERATOR—RECORD

The general purpose indicators can have side, centre, or "set-up" zeros, and can be scaled "forward" and "reverse," "ahead" and "astern," "miles per hour," &c. The output of the generator is sufficient to supply current for several additional indicators, but the number of indicators should be specified. Allowance for a change in the number of indicators coupled to a generator can be made by a substitutional resistance or adjustment on the magnetic shunt. Whenever possible the armature should be run at a normal speed of 2000 r.p.m. In the case of slow-speed engines, the armature must be geared up, whilst for high-speed engines at over 2000 r.p.m. it must be geared down. Generators can, however, be driven direct at engine speed within the limits of 1000 to 3000 r.p.m., and the indicators can be calibrated to suit the voltages corresponding to such speeds. Any moving coil indicator of the firm's manufacture can be calibrated for use with the generator, but the firm's "Cirscale" and edgewise patterns are claimed to possess outstanding advantages. The "Cirscale" indicator is best suited for use with tachometer equipments, as the scale embraces an angle of 300 deg., and in this respect resembles the mechanical type. The edgewise type of indicator is, however, invaluable where space is limited, or where the speeds of several machines have to be compared, relative speeds being distinguished by sighting pointers along their respective dials. Each movement is a separate unit, individually screened, so they can be stacked side by side in a common containing case, without affecting the readings of their neighbours, and a faulty unit can be replaced at any time by another indicator.

A complete range of A.C. and D.C. circuit breakers, made up in single, double, and triple-pole units, and varying in capacity from 15 to 2000 ampères, is to

be found on the stand, and a 500-ampère triple-pole breaker is illustrated in Fig. 59. The breakers are constructed on robust lines, and they can easily be removed from the panel. The mechanism consists of a simple toggle operated by a catch and roller. A loose handle prevents the breaker being closed or held closed on an overload, and on two and three-pole breakers one handle closes all the poles. The brush is self-aligning in all directions, and it can readily be replaced. The current density in the brush and contact is exceptionally low, with a correspondingly low milli-volt drop. The final break is made on carbon contacts. No-volt or shunt-trip devices and time lags are separate attachments and can be added at any time. The tripping of multi-pole breakers is controlled from one master mechanism, which ensures all the poles opening simultaneously, and it is impossible for one pole to open and the others to remain closed. The live parts are insulated from the frame by means of insulating links. The carbon contacts are provided with strong springs to ensure a rapid break, and arc shields are fitted between the poles. The temperature rise on the breaker and auxiliary coils complies with the B.E.S.A. specification, and the calibration is usually made from normal to 100 per cent. overload, each overload armature being calibrated individually. When time lags are required, an oil dash pot is attached to the trip lever, a scheme which only calls for one dash pot for a multi-pole breaker.

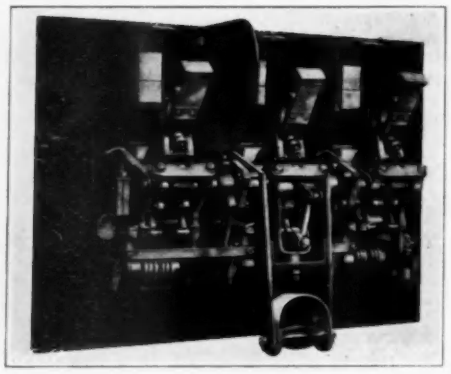


FIG. 59—500-AMPERE TRIPLE-POLE CIRCUIT BREAKER—RECORD

EVERSHED AND VIGNOLES, LTD.

Signalling and control instruments, including helm indicators, order telegraphs, and special indicators, for use on ships and in various industrial establishments, are among the exhibits of Evershed and Vignoles, Ltd., of Acton-lane Works, Chiswick, W. 4. The new ship's order telegraph transmitters shown in Fig. 60 have motor-operated pointers and a long scale. They are constructed on very robust lines. The pointers are locked in position at any given signal and a bell rings until the signal is answered. The two equipments illustrated are, of course, for two-way transmission.

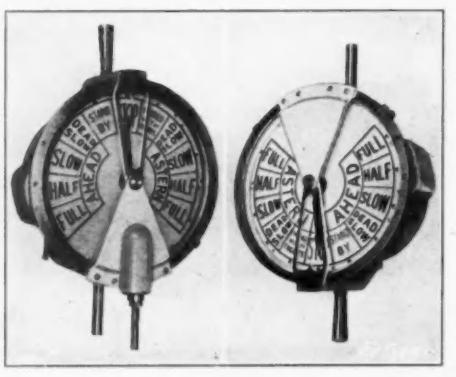


FIG. 60—ENGINE ROOM TELEGRAPHS—EVERSHED

Another interesting exhibit is the Evershed Mid-worth distance repeater equipment for the remote control of unattended sub-stations, but as this apparatus was fully described in our article on the last Physical and Optical Societies' Exhibition, it will suffice to say that the equipment will start or stop machines, raise or lower the machine voltage, open or close circuit breakers, and indicate at the control position the conditions existing at the sub-station. Full particulars of the apparatus will be found in our issue of January 16th of this year.

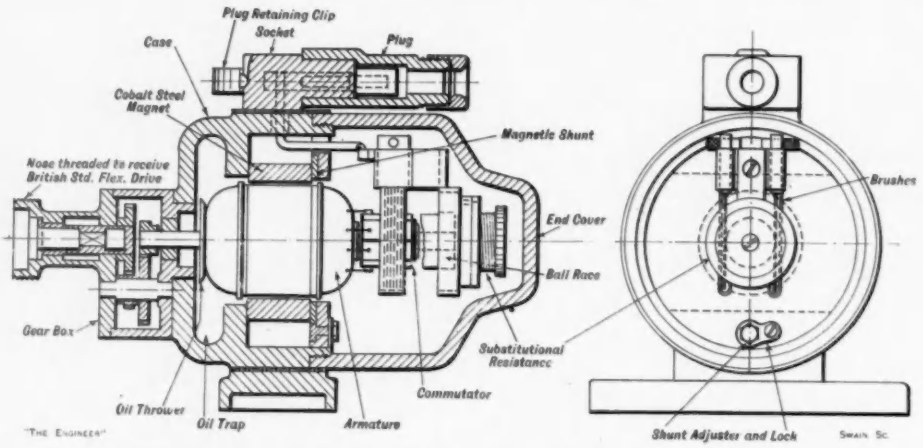


FIG. 58—SECTIONAL DRAWING OF TACHOMETER GENERATOR—RECORD

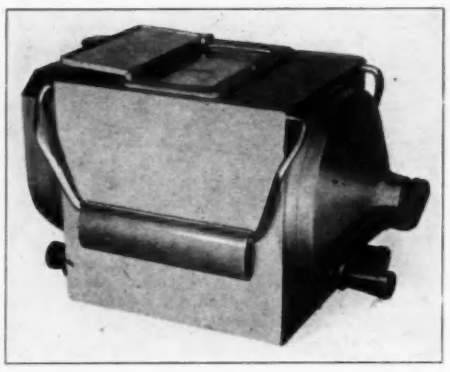


FIG. 61—EARTH TESTER—EVERSHED

The instrument shown in Fig. 61, which constitutes another exhibit, is designed to measure the resistance to earth of earth plates, overhead line towers, &c.

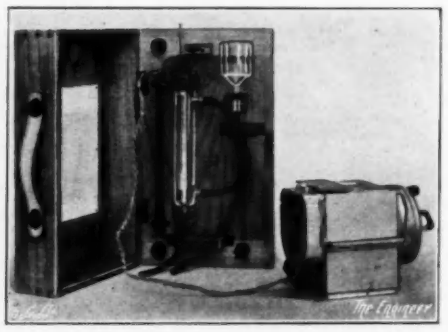


FIG. 62—DIONIC WATER TESTER—EVERSHED

It is direct reading, and is said to be very easy to use for a single test involving the use of two auxiliary earth connections immediately gives the resistance required. In addition to the ordinary earth plate tests, the instrument can be employed to measure the specific resistance to earth, and in this connection it has been found to be of considerable assistance in geophysical surveying.

For measuring the amount of impurity in water used in power stations and elsewhere the firm's Dionic water tester is now widely used, and examples of the portable types of the apparatus, as shown in Fig. 62, together with the continuous indicating and recording patterns designed for use in power stations or on ships are on view. Megger testing sets, Meg insulation testers for testing insulation resistance, Ductor low-resistance testing sets, and other forms of ohmmeters for measuring medium and low resistances are also on view. Among these exhibits is the Bridge-Meg testing set—see Fig. 63—which is a small and compact instrument combining an insulation-testing instrument having a range up to 100 megohms at 500 volts, with a Wheatstone bridge for measuring resistances down to 0·01 of an ohm. Among other exhibits there are various special forms of recording instruments, such as the firm's traction recorder for giving continuous records of qualities, such as current, voltage, and speed on electric trains and tramcars. A multi-operation recorder shown can be used to record the operation of switches and other pieces of mechanism.

FIG. 63—BRIDGE-MEG TESTING SET—EVERSHED

THE LEA RECORDER COMPANY, LTD.

Many of the exhibits on the stand of the Lea Recorder Company, Ltd., of Cornbrook Park-road, Manchester, will need little introduction to our readers, as the products of this company are so widespread in the power-houses of this and other countries. There is, however, a comparatively novel apparatus on the stand, which is illustrated diagrammatically in Fig. 64. It is intended for the measuring of the rate of flow of such materials as coal going down a chute, and might be described as the reverse of an elevator. Arranged within the chute there is a chain of the flat-link type, on to which there are occasionally attached small plates or fins. This chain runs over pulleys at the top and the bottom of the chute. The chain is, naturally, dragged down by the falling coal in the chute, and the rate of its movement will, presuming that the chute is always full, be a measure of the amount of material passing. It is then only a matter of calibrating the capacity of the chute and registering the revolutions of one of the guiding pulleys or sprockets to get a record of the amount of, say, coal going down the chute, for it has been proved, especially in the case of coal, that the weight passing through a given opening or occupying a given space, is scarcely affected by the size of the pieces of the general mass. The result is that a very simple and cheap means can be provided for measuring the amount of coal delivered to any individual boiler.

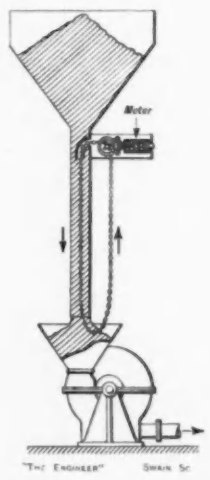


FIG. 64—DIAGRAM SHOWING PRINCIPLE OF COAL METER—LEA RECORDER

This firm is also showing a "Cube-Meter," which measures coal delivered on a horizontal travelling grate on much the same principle, some recording water meters and meters for measuring the flow of steam, water and air in pipe lines under pressure.